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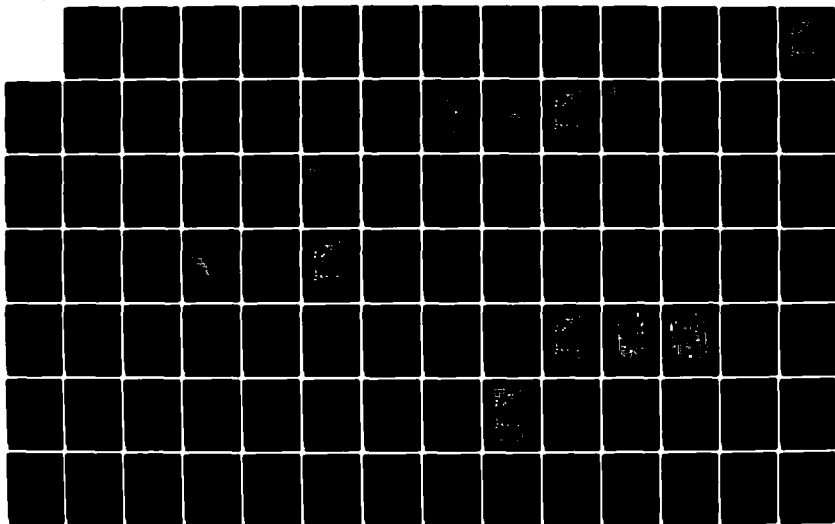
INSTALLATION RESTORATION PROGRAM PHASE I RECORDS SEARCH
VANCE AIR FORCE BASE OKLAHOMA(U) ENVIRONMENTAL SCIENCE
AND ENGINEERING INC DENVER CO JUL 84 F08637-83-G-0010

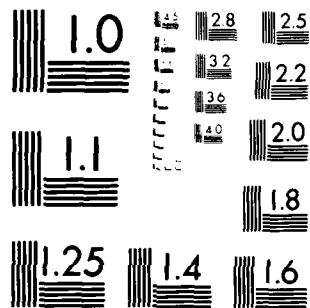
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INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH

VANCE AIR FORCE BASE
OKLAHOMA

Prepared for:

UNITED STATES AIR FORCE
HQ AFESC/DEVP
Tyndall AFB, Florida

and

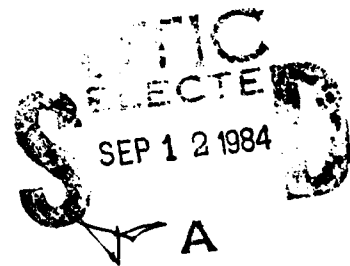
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July 1984



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ACKNOWLEDGEMENTS

The Phase I Records Search of Vance Air Force Base could not have been accomplished without the support and cooperation of numerous U.S. Air Force and civilian personnel. In particular, the Records Search Team expresses its sincere gratitude to Marilyn S. Wells and John E. Merz of Northrop Worldwide Aircraft Services Civil Engineering Department and to Colonel James A. Nugent of the 71st Air Base Group and his staff.

EXECUTIVE SUMMARY

The Department of Defense (DOD) has developed a program to identify and evaluate past hazardous material disposal sites on DOD property, control the migration of hazardous contaminants, and control hazards to health or welfare that may result from these past disposal operations. This program is called the Installation Restoration Program (IRP). The IRP has four phases consisting of Phase I, Initial Assessment/Records Search; Phase II, Confirmation and Quantification; Phase III, Technology Base Development/Evaluation of Remedial Action Alternatives; and Phase IV, Operations/Remedial Actions. The IRP will be the basis for response actions on Air Force installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, Executive Order 12316, and 40 CFR 300 Subpart F (National Oil and Hazardous Substances Contingency Plan). CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites. Environmental Science and Engineering, Inc. was retained by the United States Air Force to conduct the Phase I, Initial Assessment/Records Search for Vance Air Force Base (VAFB) and its subinstallation, Kegelman Auxiliary Field (KAux) under Contract No. F08637-83-G0010-5000.

INSTALLATION DESCRIPTION

VAFB is located in north-central Oklahoma, approximately 5 miles south of downtown Enid, which is the seat of Garfield County. The family housing area of VAFB lies within the Enid city limits. KAux is located approximately 30 miles north-northwest of VAFB in Alfalfa County, Oklahoma, just east of the Great Salt Plains Reservoir.

VAFB is the home of the 71st Flying Training Wing which has the mission of conducting undergraduate pilot training. The 11-month undergraduate pilot training program consists of 175 hours of flying, 367 hours of academic training, and 134 hours of officer training, the accumulation of which qualifies the student as an Air Force pilot.

The basic mission of VAFB has remained essentially the same since the base was first activated. However, over that period the type of aircraft being

flown has changed several times. Between 1942 and 1956, propeller-driven aircraft were used. These were followed by the T-33 between 1956 and 1960. The T-37 was introduced in 1960 and was joined by the T-38 in 1964.

ENVIRONMENTAL SETTING

The environmental setting data reviewed for this investigation indicate the following major points that are relevant to the evaluation of past hazardous waste management practices at VAFB and KAux:

- o Mean annual precipitation is 27.9 inches with a lake evaporation rate of approximately 60 inches per year. Wind direction is variable with a predominance from the south.
- o Both VAFB and KAux lie within the Arkansas River Basin. VAFB is located on a topographic high, and there is no on-flow of surface water from adjacent areas. In general, the north and central sections of the base drain to Boggy Creek. The southern portions of the base drain into Hackberry Creek. KAux lies immediately south of the Salt Fork of the Arkansas River, draining directly to the river through a number of small channels.
- o The soils at VAFB and KAux are generally fine sandy loams that are well-drained. These soils tend to be underlain at a depth of 2-4 feet with clay layers. These layers are generally discontinuous and do not constitute an aquiclude.
- o VAFB and KAux are underlain by minor local aquifers. Ground water occurs in strata that are predominantly shale with some siltstone and fine-grained sandstone. Recharge is from local precipitation, and well yields are small.
- o Ground water in the vicinity of VAFB and KAux is characterized by variable quality, with sulfate, chloride, nitrate, dissolved solids, and hardness often in concentrations exceeding recommended upper limits for drinking water. These conditions are not thought to be related to activities at VAFB or KAux.
- o No threatened or endangered species regularly inhabit either VAFB or KAux.

METHODOLOGY

The objective of Phase I was to identify the potential for environmental contamination from past waste disposal practices at VAFB and to assess the potential for contaminant migration. Activities performed in the Phase I study included review of site records; interviews with personnel familiar with past generation and disposal activities; determination of estimated quantities and locations of current and past hazardous waste treatment, storage, and disposal; performance of field and aerial inspections; and development of conclusions and recommendations.

FINDINGS AND CONCLUSIONS

All the major industrial operations at VAFB relate to the maintenance and operation of the aircraft used in pilot training. The different levels of maintenance and the various operations are conducted by several different organizations at a number of locations on the base. Operations include engine repairs/overhauls; electrical, hydraulic, and fuel system repairs; painting; metal plating/finishing; support equipment maintenance, fuel supply and handling, and maintenance of base facilities. No industrial activities are conducted at KAux and there is no underground fuel storage.

The materials, construction, and maintenance requirements of the earlier aircraft differed from those currently in use. Thus, the specific equipment and materials used in current maintenance operations may not reflect the years prior to 1960, although the categories of maintenance being performed and the locations where they are conducted have changed little.

The main types of waste generated at VAFB are fuel, oils and solvents, paints and paint strippers, and metal plating/treatment solutions. Waste fuel, oil, and solvents include JP4, engine oil, PD680, and acetone, which are derived primarily from periodic maintenance and engine repair operations. Waste consisting of paint residue, strippers, and thinner is generated by the parts, aircraft, and vehicle painting operations. Metal plating/treatment waste is generated at the jet engine shop and metal plating shops and consists of phosphoric acid, chromic acid, potassium permanganate, cadmium, and descaling solutions. The general trend in waste disposal over the years since VAFB first began operation has been from

largely unsegregated disposal in base landfills toward extensive waste segregation and contract disposal.

This study identified eight areas on VAFB subject to contamination by industrial and/or hazardous waste as a result of handling and disposal practices (Figure 1). Of these eight areas of potential contamination, six were determined to require rating with the Hazard Assessment Rating Methodology (HARM) system. The Bldg. 110 Area Storage Tank and the Hazardous Waste Accumulation Point were not rated due to the lack of potential for contamination and migration. No evidence was found of leakage or spills at either of these two sites. The HARM scores for the six remaining sites are summarized in Table 1.

Tank Farm Landfill

This site was operated as a general purpose trench and fill landfill prior to 1952. Operating personnel reported the contents were mostly household solid wastes, but included containerized liquids. Some lead gasoline tank sludge was buried under the existing berm around Tank 267. The potential exists for contamination and migration from metals, solvents, fuels, and oils.

East Boundary Landfill

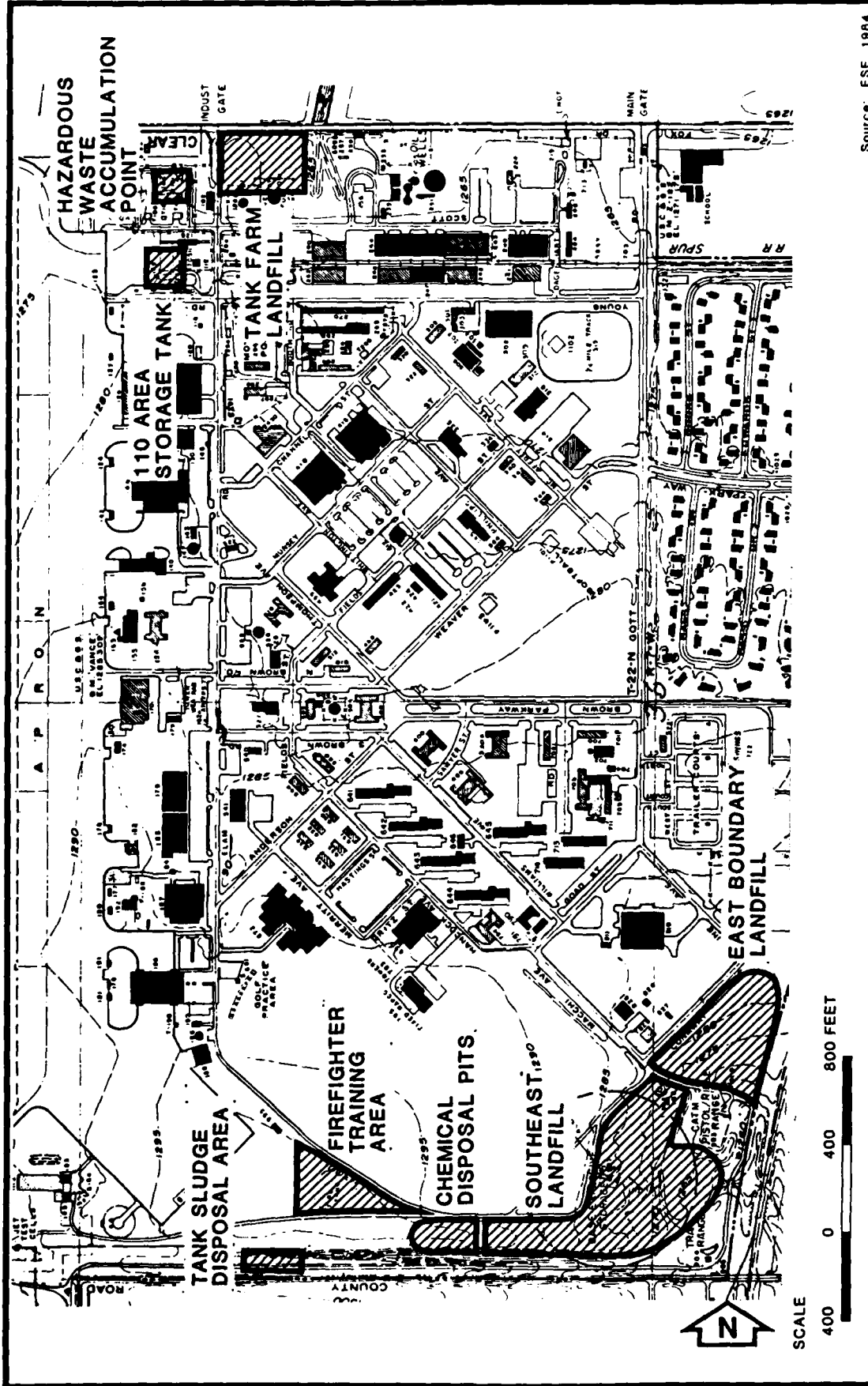
Operated as a general purpose trench type landfill from approximately 1952 to 1957, this area is currently cultivated as garden plots by base personnel. Materials deposited here were mostly general solid waste and some industrial liquids. Potential exists for contamination by and/or migration of metals, solvents, fuels, and oils.

Southeast Landfill

Trench and fill disposal of solid waste proceeded through this area from 1958 to 1965. Disposal of industrial wastes in this area is thought to be limited. Some potential exists for contamination by metals and solvents.

Chemical Disposal Pits

This open area adjacent to the south boundary drainage ditch was used to dig a series of liquid waste disposal pits from approximately 1960 to 1970.



Source: ESE, 1984

INSTALLATION RESTORATION PROGRAM Vance Air Force Base

Figure 1
AREAS OF POTENTIAL CONTAMINATION

Table 1 - Summary of HARM Scores

Rank	Site	Receptors Subscore	Waste Characteristics Score	Pathways Subscore	Waste Management Factor	Total Score
1	Chemical Disposal Pits	61	100	52	1.0	71
2	Firefighter Training Area	61	64	44	1.0	56
3	Tank Farm Landfill	64	56	44	1.0	55
4	East Boundary Landfill	61	30	52	1.0	48
5	Tank Sludge Disposal Area	61	37	44	1.0	47
6	Southeast Landfill	61	10	52	1.0	41

Source: ESE, 1984.

Soils are relatively impermeable, but potential contamination or migration exists, primarily for metals since materials disposed of were mostly plating solutions and sludges.

Tank Sludge Disposal Area

Used as a one-time disposal area for sludge from fuel tanks, this site is between the drainage ditch and south base boundary. Potential exists for metals contamination and migration.

Firefighter Training Area

Fuels, oils, and solvents were reportedly dumped in a shallow ground depression at this location until approximately 1970. A new Firefighter Training Area is located on the site.

RECOMMENDATIONS

Recommendations for Phase II monitoring include installation of 11 monitoring wells to be sampled and analyzed for a variety of contaminants. Water level measurements and geophysical logging of boreholes are included as part of the program. Surface water and sediment analyses are recommended on ditches draining the known disposal areas to provide data on this potential migration pathway. Soil analyses are included in the Firefighter Training Area, where contamination of near surface soils may exist, and at the East Boundary Landfill, where food crops are being grown in the cover material of the old landfill.

1.0 INTRODUCTION

1.1 BACKGROUND

Due to its primary mission, the U.S. Air Force (USAF) has long been engaged in operations dealing with toxic and hazardous materials. Federal, state, and local governments have developed strict regulations to require that disposers identify the locations and contents of disposal site and take action to eliminate the hazards in an environmentally responsible manner. The primary Federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Sec. 6003 of the Act, Federal Agencies are directed to assist the U.S. Environmental Protection (EPA) and under Sec. 3012, state agencies are required to inventory past disposal sites and make the information available to the requesting agencies. To assure compliance with these hazardous waste regulations, the Department of Defense (DOD) developed the Installation Restoration Program (IRP). The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated Dec. 11, 1981, and implemented by USAF message, dated Jan. 21, 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the IRP. DOD policy is to identify and fully evaluate suspected problems associated with past hazardous contamination and to control hazards to health and welfare that resulted from these past operations. The IRP will be the basis for response action on USAF installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as clarified by Executive Order 12316, and 40 CFR 300 Subpart F (National Oil and Hazardous Substances Contingency Plan). CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites.

1.2 PURPOSE, AUTHORITY, AND SCOPE OF THE ASSESSMENT

The IRP has been developed as a four-phase program, as follows:

- Phase I - Initial Assessment/Records Search
- Phase II - Confirmation and Quantification
- Phase III - Technology Base Development
- Phase IV - Operations/Remedial Actions

Environmental Science and Engineering, Inc. (ESE) conducted the records search at Vance Air Force Base (VAFB) and its subinstallation, Kegelman Auxiliary Field (KAux), with funds provided by the Air Force Training Command (ATC). This report contains a summary and evaluation of the information collected during Phase I of the IRP and recommendations for any necessary Phase II action.

The objective of Phase I was to identify the potential for environmental contamination from past waste disposal practices at VAFB and to assess the potential for contaminant migration. Activities performed in the Phase I study included the following:

1. Review of site records;
2. Interviews with personnel familiar with past generation and disposal activities;
3. Inventory of wastes;
4. Determination of estimated quantities and locations of current and past hazardous waste treatment, storage, and disposal;
5. Definition of the environmental setting at the base;
6. Review of past disposal practices and methods;
7. Performance of field and aerial inspections;
8. Gathering of pertinent information from federal, state, and local agencies.
9. Assessment of potential for contaminant migration; and
10. Development of conclusions and recommendations for follow-on action.

ESE performed the onsite portion of the records search during March 1984.

The following team of professionals was involved:

- o Bruce N. McMaster, Ph.D., Senior Chemist and Project Manager, 16 years of professional experience.
- o Jackson B. Sosebee, Jr., Chemist/Geologist and Team Leader, 12 years of professional experience.
- o William G. Fraser, P.E., Environmental Engineer, 9 years of professional experience.
- o Keith C. Govro, Ecologist, 9 years of professional experience.

Detailed information on these individuals is presented in Appendix B

1.3 METHODOLOGY

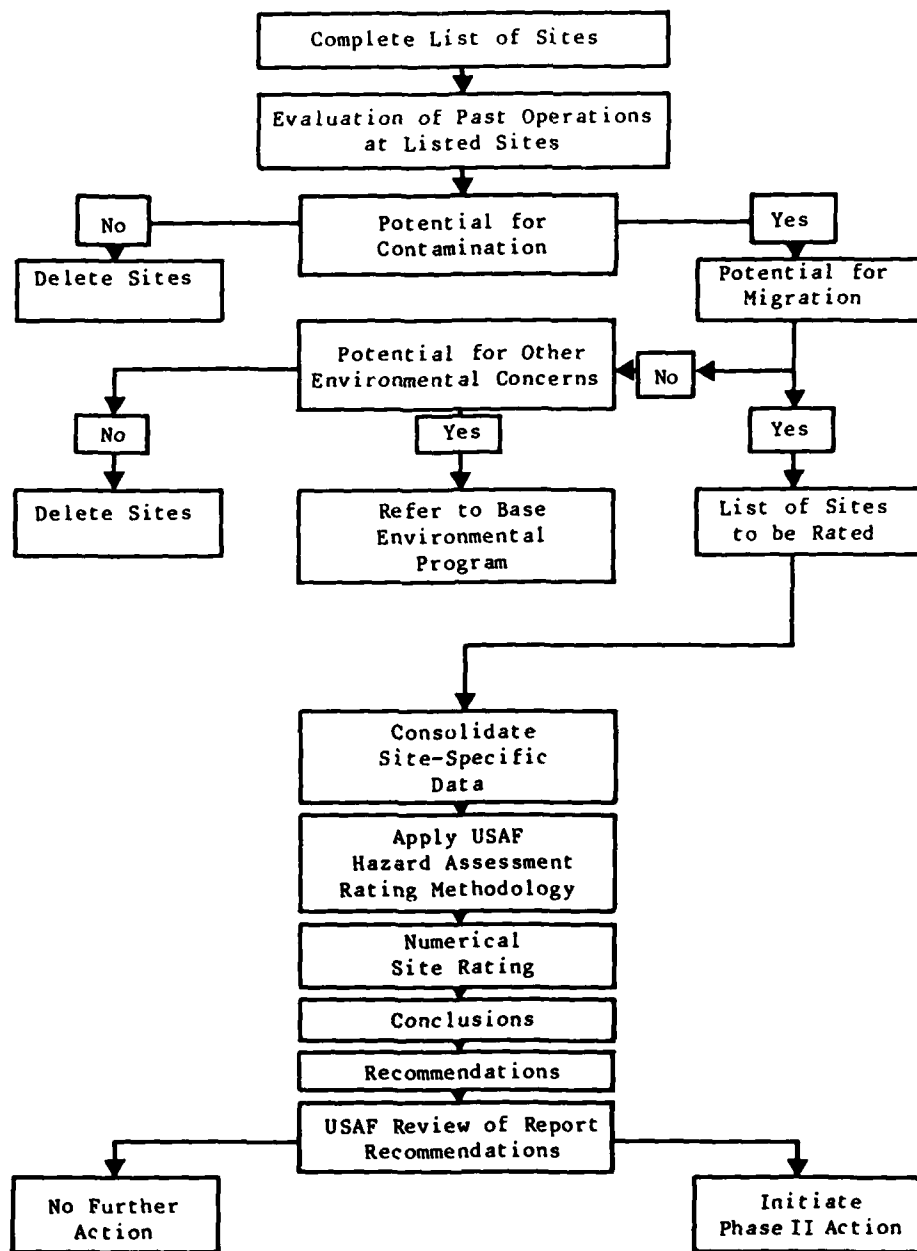
The methodology utilized in the VAFB records search began with a review of past and current industrial operations conducted at the base. Information was obtained from available records, such as shop files and real property files, as well as interviews with past and current base employees from the various operating areas. Interviewees included current and past Air Force personnel and those associated with Northrop Worldwide Aircraft Services, Inc. or previous base operations contractors, Bioenvironmental Engineering Services (BES), and tenant organizations on the base. A list of interviewees by position and approximate years of service is presented in Appendix C.

The next step in the activity review was to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various operations on the base. Included in this part of the activities review was the identification of all known past disposal sites and other possible sources of contamination, such as spill areas.

A ground tour and helicopter overflight of the identified sites were then made by the ESE Project Team to gather site-specific information including: (1) visual evidence of environmental stress; (2) the presence of nearby drainage ditches or surface water bodies; and (3) visual inspection of these water bodies for any obvious signs of contamination or leachate migration.

Using the process shown in Fig. 1.3-1, a decision was then made, based on all of the above information, regarding the potential for hazardous material contamination at any of the identified sites. If no potential existed, the site was deleted from further consideration. If potential for contamination was identified, the potential for migration of the contaminant was assessed based on site-specific conditions. If there were no further environmental concerns, the site was deleted. If the potential for contaminant migration was considered significant, the site was evaluated and prioritized using the Hazard Assessment Rating Methodology (HARM). A discussion of the HARM system is present in Appendix H. The sites, which were evaluated using the HARM procedures, were also reviewed with regard to future land use restrictions.

INSTALLATION RESTORATION PROGRAM
PHASE I--RECORDS SEARCH
DECISION PROCESS



Source: AFESC, 1982

Figure 1.3-1
DECISION PROCESS

INSTALLATION
RESTORATION PROGRAM
Vance Air Force Base

2.0 INSTALLATION DESCRIPTION

2.1 LOCATION/SIZE

VAFB is located in north-central Oklahoma, approximately 5 miles south of downtown Enid, which is the seat of Garfield County (Fig. 2.1-1). The family housing area of VAFB lies within the Enid city limits. KAux is located approximately 30 miles north-northwest of VAFB in Alfalfa County, Oklahoma, just east of the Great Salt Plains Reservoir.

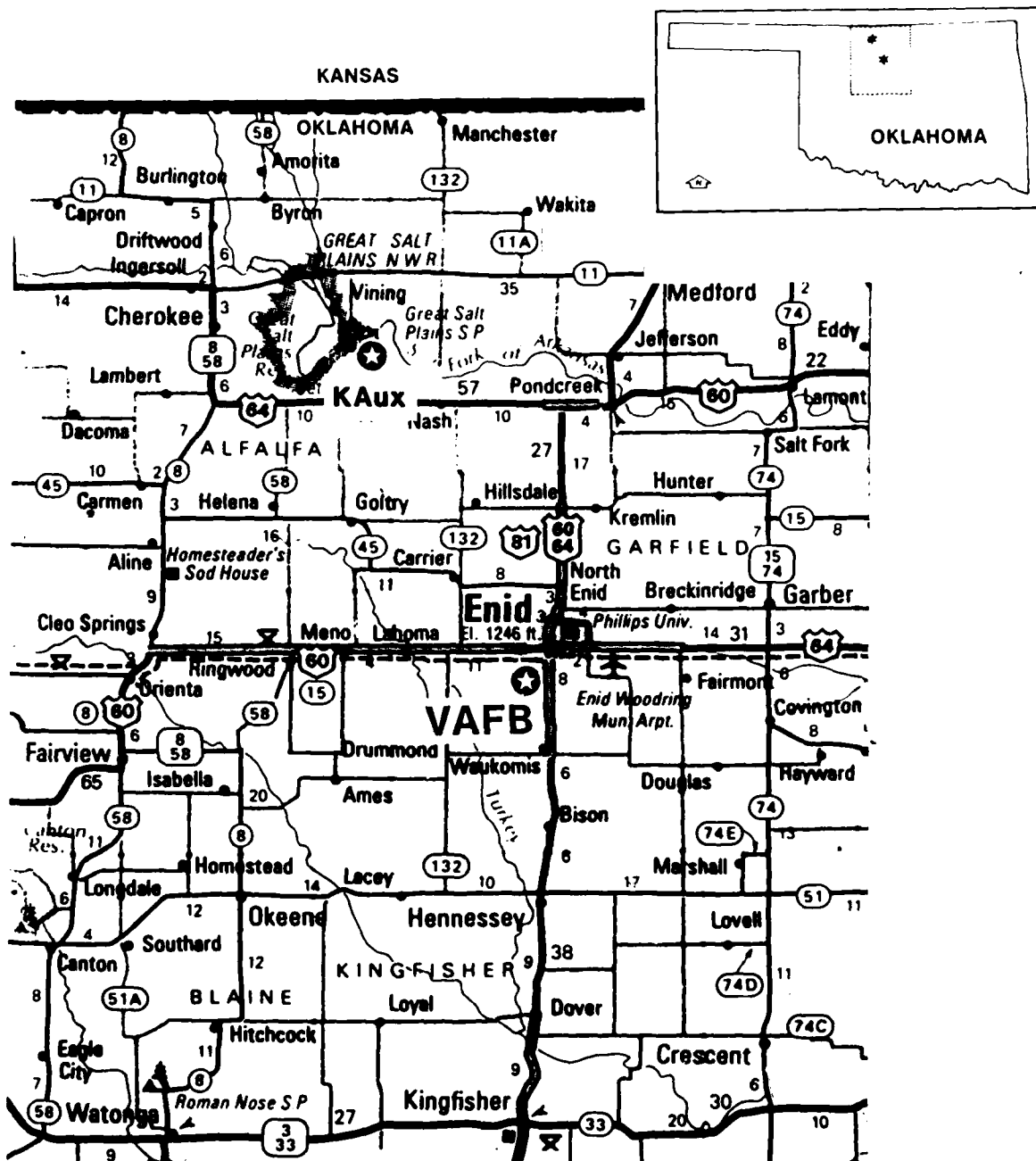
The runways and taxiways at VAFB cover 1,100 of the 1,847 acres which make up the base. The remaining area comprises maintenance shops, operations, housing, and recreation areas (Figs. 2.1-2 and 2.1-3). Outgrants associated with VAFB include leases of 0.021 acres to the telephone company, 0.148 acres to the credit union, 0.02 acres to the bank, and 1 acre to Cotton Petroleum Co. VAFB leases 60.345 acres from private parties for military family housing.

KAux covers a total of 1,066 acres, of which 365 acres are airfield and operations areas (Fig. 2.1-4). The remainder is largely unimproved (VAFB, 1976). Approximately 7 acres of KAux is leased to private parties for grazing. KAux obtains water from three wells which are located on 4 acres of land leased from other parties. A small pond (0.5 acres) is currently being developed on KAux for public fishing.

2.2 HISTORY

The installation was initially authorized under the Fourth Supplemental National Defense Appropriation Act of 1941, Mar. 7, 1941. Construction was begun in July 1941, and the first buildings were occupied in November of that year. The land on which the base was constructed was primarily cattle range in the years before 1893, when a land rush resulted in its conversion to wheat production. By 1941, when the land was transferred to the federal government, Enid was a principal grain storage terminal and flour milling center and was fast becoming an important petroleum production and refining center.

The base was officially named Enid Army Flying School on Feb. 11, 1942. It was used for basic pilot training in the T-13a and T-15 aircraft through



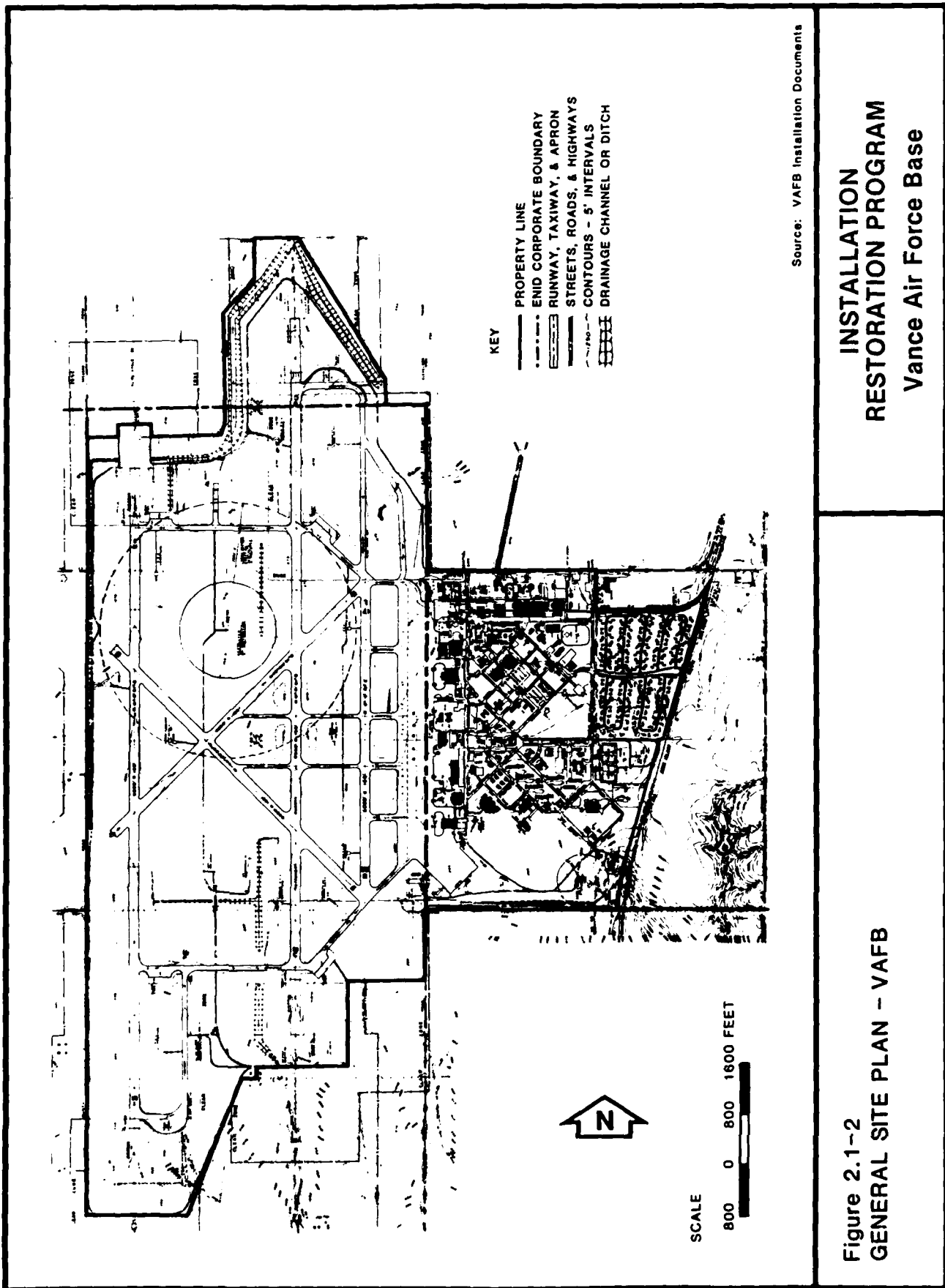
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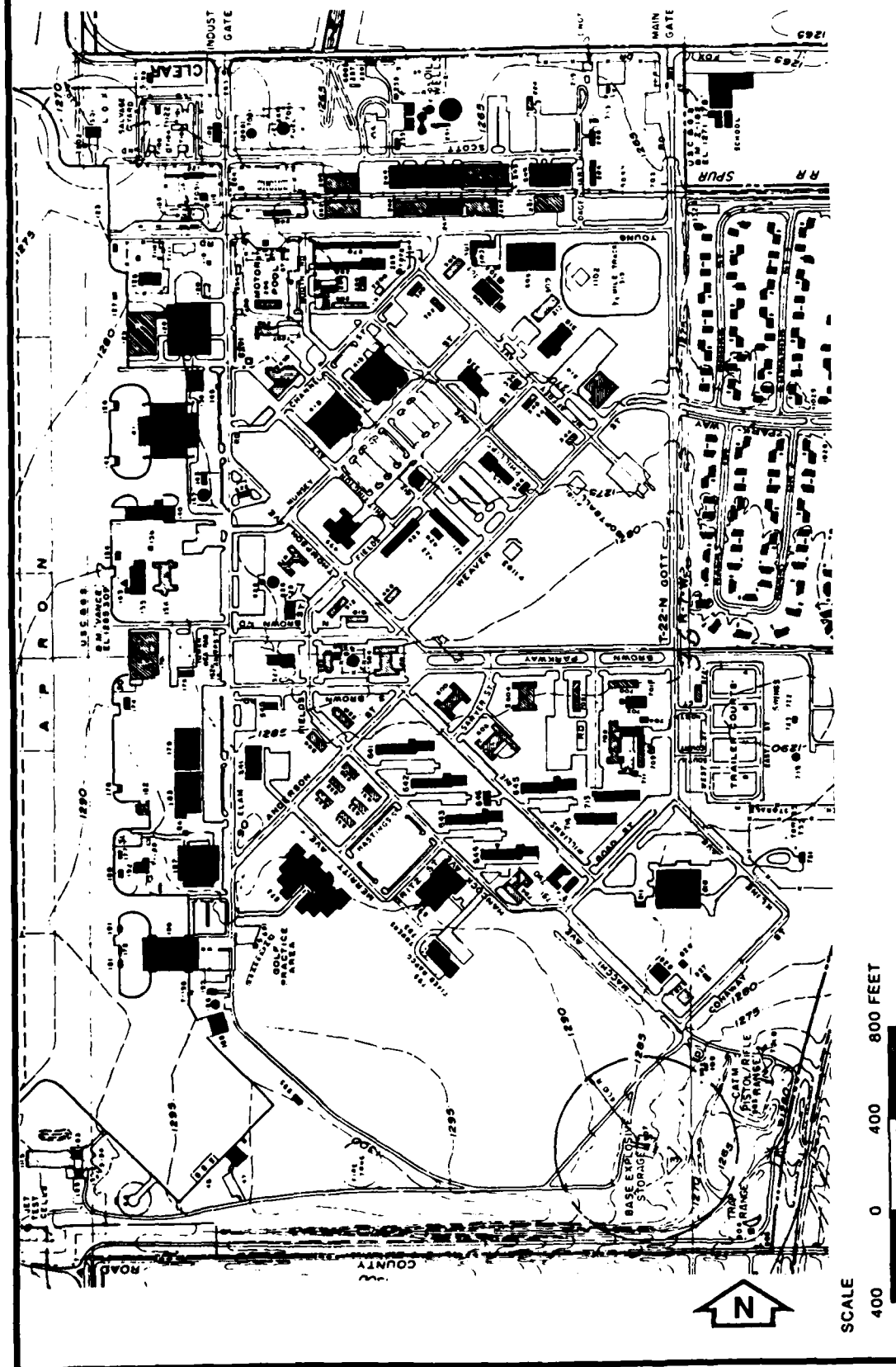


Source: Commercial Highway Map

Figure 2.1-1
LOCATION MAP

INSTALLATION RESTORATION PROGRAM Vance Air Force Base

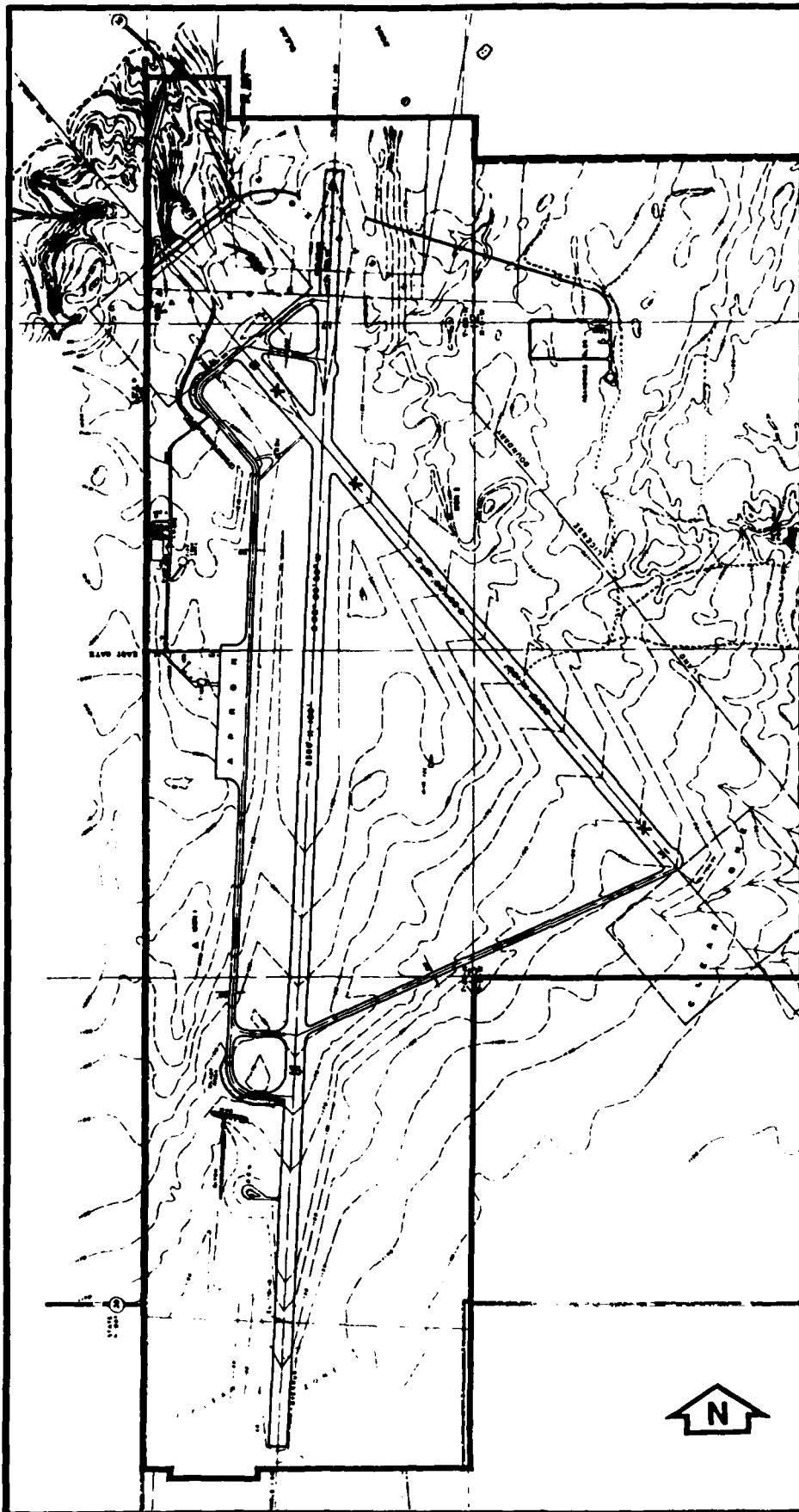




Source: VAFB Installation Documents

INSTALLATION RESTORATION PROGRAM Vance Air Force Base

Figure 2.1-3
OPERATIONS AREA - VAFB



KEY

- PROPERTY LINE
- ▬ RUNWAY, TAXIWAY, & APRON
- ▬ STREETS, ROADS, & HIGHWAYS
- CONTOURS - 5' INTERVALS
- ▬ DRAINAGE CHANNEL OR DITCH

SCALE

400 0 400 800 FEET

Source: VAFB Installation Documents

INSTALLATION RESTORATION PROGRAM Vance Air Force Base

Figure 2.1-4
GENERAL SITE PLAN - KAUX

much of World War II. In 1944, advanced students began training in the B-25 and B-26. With the conclusion of the war and the reduced need for pilots, the base was closed on Jan. 31, 1947.

Following the creation of the USAF as a separate service in 1947, the base was reactivated under the name Enid Air Force Base on Jan. 13, 1948. The mission at that time was to provide advanced pilot training in the T-6 and B-25 aircraft. On July 9, 1949, the base was renamed VAFB.

By 1952, when the VAFB mission was changed from advanced to basic pilot training, the T-6 aircraft had been replaced by the T-28. As advances in aviation continued over the next decade, several more changes in aircraft took place. In 1956, the T-33 single engine trainer replaced the B-25. In 1960, the twin-engine T-37 replaced the T-28, and by 1964, the T-33 had been replaced by the supersonic T-38.

A major expansion of the runway systems was required to support the new aircraft, which operated at much greater speeds. During 1955 and 1956, the existing north-south runways were extended, and a third north-south runway was constructed. This included an expansion of the base boundaries, and extensive alterations to the taxiway, drainage, lighting, and traffic control systems.

In 1960, VAFB was selected by the Air Force as part of an extended experiment in contract services under which a civilian contractor provides the support facilities normally provided by base agencies. This includes aircraft and base maintenance, ground transportation, fire protection, procurement, supply, and other services. The base has continued to operate under this system, providing basic pilot training in the T-37 and T-38 aircraft. The initial contractor, Serve-Air, Inc., operated the base until 1972, when the contract was taken over by Northrop Worldwide Aircraft Services.

KAux originally consisted of 960 acres on which airfield pavements and facilities were constructed during World War II (1942 to 1943). An

additional 10 acres were purchased in 1943. It was activated in January 1944 as Great Salt Plains Auxiliary Field Operational Training Unit. After the war it was inactivated. In August 1948 it was reactivated. The field was renamed Kegelman Auxiliary Field after Colonel Charles C. Kegelman from El Reno, Oklahoma, in July 1949. In 1960, 15 acres were purchased, and in 1965, an additional 81 acres were purchased, which totaled 1066 acres for the present site.

2.3 ORGANIZATION AND MISSION

VAFB is the home of the 71st Flying Training Wing (FTW) which has the mission of conducting undergraduate pilot training. The 11-month undergraduate pilot training program consists of 175 hours of flying, 367 hours of academic training, and 134 hours of officer training, the accumulation of which qualifies the student as an Air Force pilot.

In the first phase of training the students start their academic instruction. This consists primarily of flight physiology and aircraft systems training. Jet flying starts during the fourth week of training. In the second phase, the students fly the Cessna T-37, a small twin engine jet trainer with a top speed of 350 miles per hour (mph) and a ceiling of 25,000 feet. Each student receives 32 hours of instrument flight simulator training during the T-37 phase. The five-month third phase of training is given in the Northrop T-38 Talon jet trainer. It is a supersonic plane with a top speed of 800 mph and a ceiling of 39,000 feet. The academic and flying training in the third phase includes 34 hours in the T-38 instrument flight simulator.

VAFB trains approximately 400 pilots per year. The working population at the base is approximately 2,600. Air Force personnel and dependents living on base total approximately 850.

The 71st Air Base Group has the two-fold mission of providing limited administrative services and support to the mission and base and providing contract surveillance to assure Northrop Worldwide Aircraft Services is providing those operations and services for which the civilian contractor is responsible. The main contract services are aircraft maintenance, facilities

maintenance, civil engineering, flight simulation, open mess, personnel services, and management services.

2.4 MAJOR TENANTS

The 2110 Communications Squadron (AFCS) directly supports the 71st FTW by providing operations and maintenance of all air traffic control facilities and systems located at VAFB. Additionally, the 2110 AFCS maintains the UHF radios and meteorological equipment installed at VAFB and KAux.

Detachment 15, 24th Weather Squadron, provides weather support to the 71st FTW to fulfill its mission. Additionally, Detachment 15 provides weather support to transient aircrews and other base agencies.

The Defense Investigative Service (DIS) conducts personal security background investigations on military, DOD civilians, and Defense Contractor personnel whose duties require access to classified defense information.

3.0 ENVIRONMENTAL SETTING

3.1 METEOROLOGY

The VAFB region is classified as moist sub-humid as precipitation exceeds that required for normal plant growth. At the base, instrument flight rule (IFR) conditions prevail only 8 percent of the time. These conditions occur more frequently in the winter and only infrequently in the summer. Temperature and precipitation data for the base are summarized in Table 3.1-1. Average daily maximum and minimum temperatures range from 44°F and 25°F in January to 93°F and 72°F in July. Mean monthly precipitation ranges from 5.4 inches in May to 0.8 inches in December. Winds are calm only about 7 percent of the time, averaging 9 knots (kts) over the year. Wind direction is variable with a predominance from the south. Mean annual precipitation in the area is 27.9 inches. Lake evaporation is approximately 60 inches per year.

Severe weather is common at VAFB, particularly in the spring and early summer when thunderstorms are frequently accompanied by hail and occasionally by tornados. Blizzard conditions can occur in the winter, although snowfall is generally limited, averaging only 12 inches per year. The maximum 24-hour precipitation is 9.3 inches, the maximum 24-hour snowfall is 10.9 inches. The one-year 24-hour rainfall is approximately 2.7 inches. Daily maximum temperatures exceed 90°F an average of 72 days per year, while daily minimums dip below 32°F an average of 82 days per year.

Detailed weather data for KAux are not recorded separately from VAFB. The proximity to Great Salt Plains Reservoir may cause temperatures and rainfall to vary somewhat from those recorded at VAFB, but the general pattern should be similar.

3.2 GEOGRAPHY

3.2.1 PHYSIOGRAPHY

The gently rolling uplands between the Cimmaron and Salt Fork rivers where VAFB and KAux are located are part of the Enid Prairies subdivision of the

Table 3.1-1 - VAFB Climatic Summary.

	Temperature °F		Precipitation (in)		Wind	
	Mean Daily Max.	Min.	Mean	Max. 24-hr	Prevailing Direction	Speed Mean (kts)
January	44	25	1.0	1.9	N	9
February	50	30	1.3	2.9	N	10
March	59	37	1.6	2.1	S	10
April	70	49	3.0	7.0	S	10
May	79	56	5.4	6.8	S	8
June	88	67	3.3	4.3	S	9
July	93	72	2.6	5.8	S	8
August	92	71	2.7	2.9	S	8
September	83	62	2.8	1.8	S	8
October	73	51	1.9	9.3	S	9
November	58	38	1.5	3.3	S	8
December	48	29	0.8	1.8	N	9
Annual	70	49	27.9	9.3	S	9

Period of Record: January 1942-December 1981.

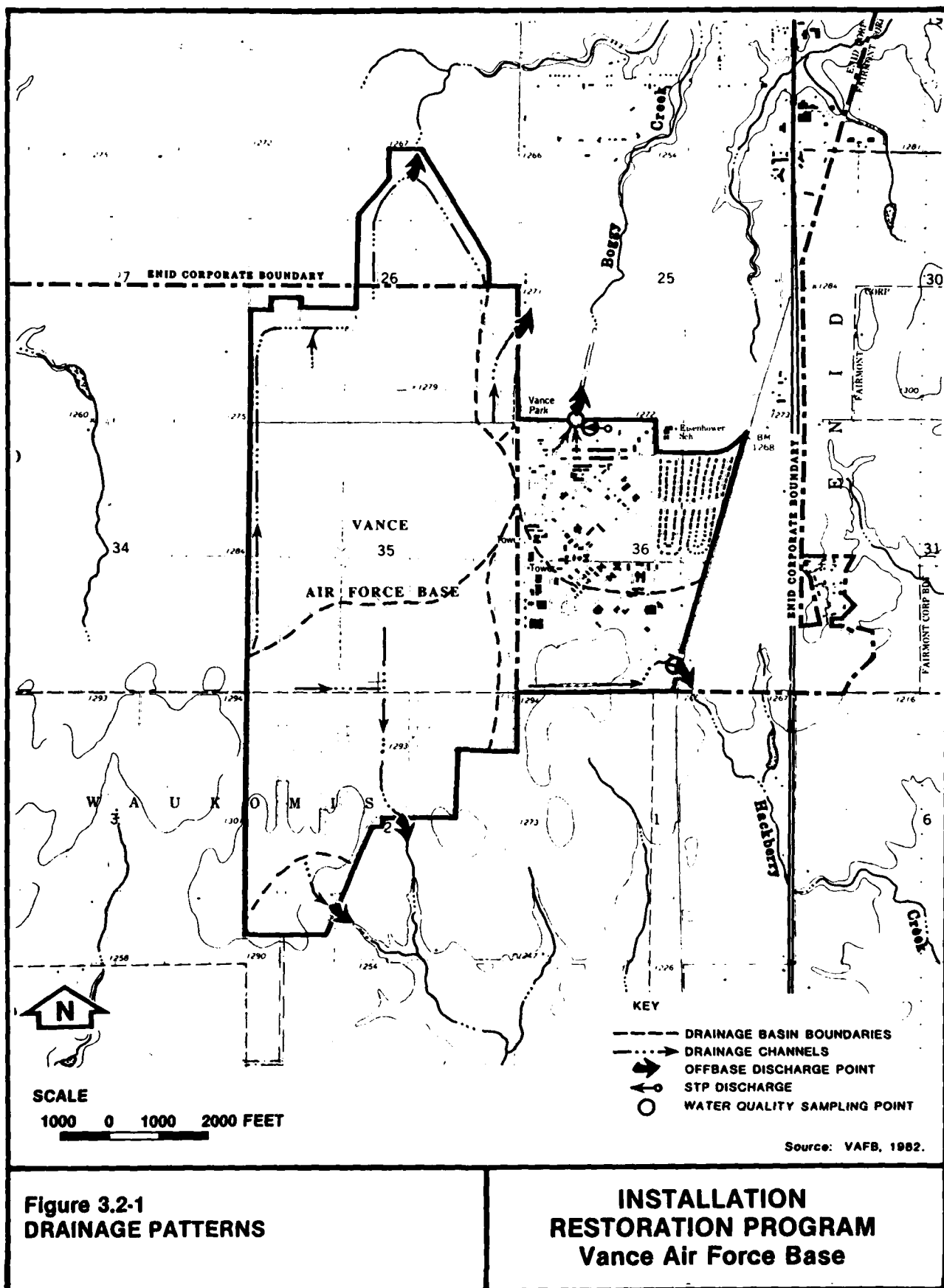
Source: USAFETAC, 1982.

Great Plains physiographic province. Oklahoma has been divided into 22 geomorphic provinces as defined by the dominant land forms in each. VAFB is within the Central Redbed Plains. This province covers a large part of North-Central Oklahoma and is characterized by gently rolling hills cut into outcrops of Permian red shales, siltstones, and sandstones. The surface slope of the area is generally eastward with a broad divide near Enid. KAux is located in the Western Sand Dune Belts, areas of hummocky topography which lie in comparatively narrow strips primarily along the north and east sides of major streams. This is an area of stabilized sand dunes formed by wind and water action on the sands of the braided stream channels (Johnson, et al., 1979).

3.2.2 SURFACE HYDROLOGY

The area of North-Central Oklahoma containing VAFB and KAux lies within the Arkansas River Basin. VAFB lies within the Cimmaron River sub-basin, and KAux in the Salt Fork sub-basin. Other major sub-basins in the region are the Chikaskia and North Canadian Rivers. All these rivers flow in a generally southeastwardly direction toward the main stem of the Arkansas. There are no natural lakes in the region, but man-made lakes such as Canton Lake and the Great Salt Plains Reservoir are the major surface water features of the area. They constitute an important recreational resource and wildlife habitat.

The airfield and operating areas of VAFB are located on a topographic high and are drained by a series of man-made ditches, which route stormwater off the base as shown in Fig. 3.2-1. There is no on-flow of surface water from off-base areas. All base property lies outside the 100-year flood plain. In general, the north and central sections of the base drain to Boggy Creek. This flow includes the discharge from VAFB sewage treatment plant (STP), which is the only flow crossing the base boundary during dry periods. Boggy Creek flows northeasterly approximately two miles before entering a small municipal lake which is used for fishing and pleasure boating. Boggy Creek subsequently joins Skelton Creek, which is tributary to the Cimmaron River. The southern portions of the base drain into Hackberry Creek, an ephemeral stream which passes through a series of agricultural impoundments before joining Skelton Creek. VAFB is approximately 50 river miles from



the Skelton Creek confluence with the Cimmaron River. KAux lies immediately south of the Salt Fork of the Arkansas River, draining directly to the river through a number of small channels (Fig. 3.2-2). A man-made impoundment near the eastern KAux boundary has been developed as a recreational site by VAFB civil engineering.

3.3 GEOLOGY

3.3.1 GEOLOGIC SETTING

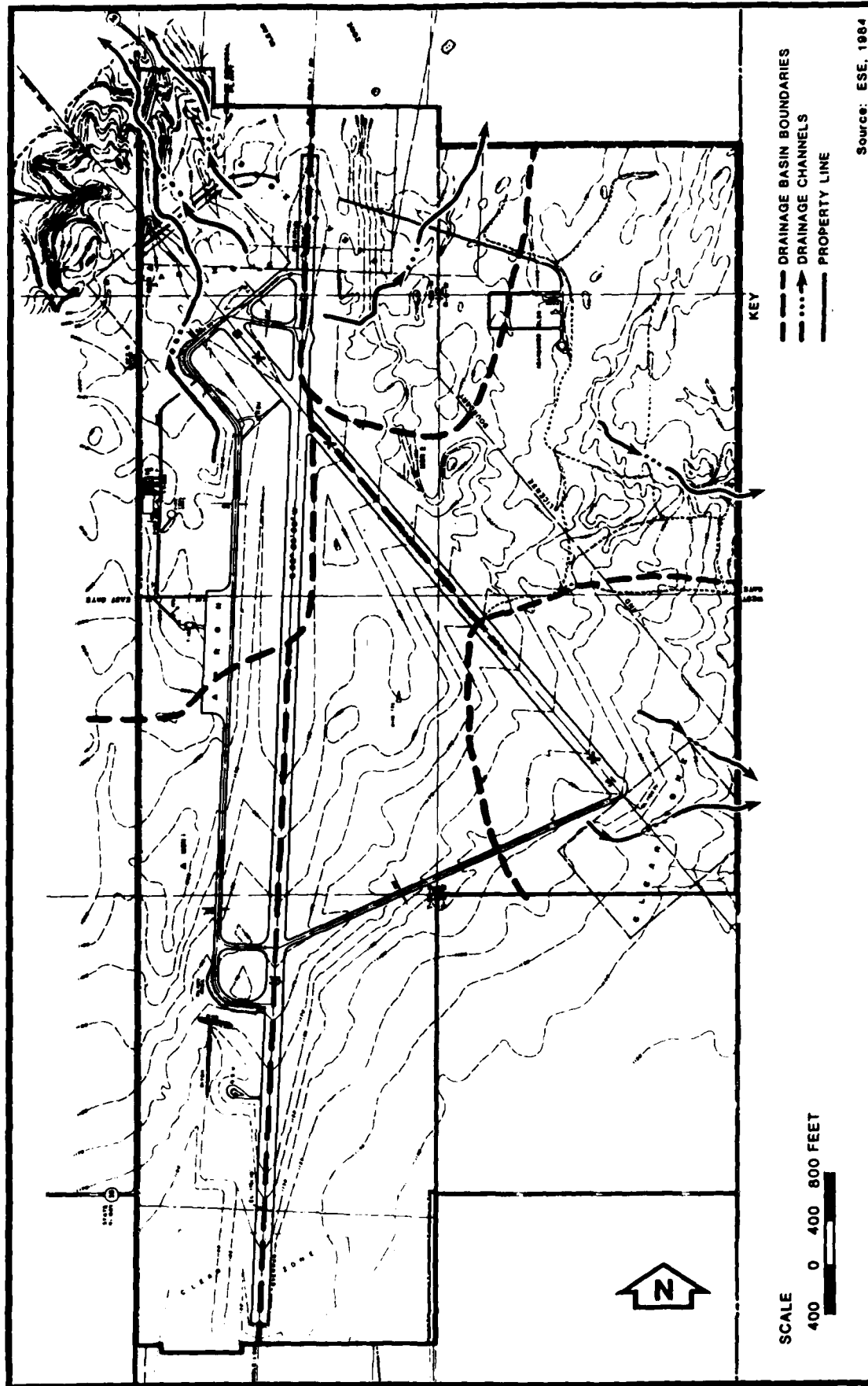
Geologic History

Two distinct intercontinental geosynclines or basins were formed in southern Oklahoma during the Paleozoic era: (1) the pre-middle Devonian Wichita basin, and (2) the Anadarko basin of late Paleozoic age (Caylor, 1957).

Maximum subsidence in the Wichita basin occurred along a line extending west-northwest and east-southeast through southern Oklahoma and parts of northern Texas. The Wichita basin was the site where great thicknesses of late Cambrian, Ordovician, and Silurian-Devonian sediments accumulated. These sediments are mostly massive marine limestones, which thin northward but maintain a similar lithology into northern Oklahoma and the northern mid-continent region. In the vicinity of VAFB, these rocks have an aggregate thickness of some 3000 ft.

The initial rocks to be deposited in the marine waters which entered the Wichita basin during late Cambrian time was a bed of arkosic sandstone which is probably of wide areal extent and overlies Precambrian basement rocks. Continued subsidence and deposition of massive marine limestones (Arbuckle Group) followed in late Cambrian and Ordovician time. These beds were probably deposited in shallow marine waters and were perhaps derived from weathering of outcrops of igneous and metamorphic rocks of the North American craton. Some evidence of subsequent weathering of the Arbuckle group has been found at various places in northern Oklahoma. Deposition appears to have been more or less continuous during late Ordovician time.

In late or middle Devonian time, general emergence occurred over much of the mid-continent region. These widespread crustal movements were



INSTALLATION RESTORATION PROGRAM Vance Air Force Base

**Figure 3.2-2
DRAINAGE PATTERNS - KAUX**

accompanied by gentle uplifting of broad arches which extended in a northwest-southeast direction through central Kansas, northeastern Oklahoma, and southwestern Missouri. In the vicinity of VAFB the effects of these uplifts were the regional southward tilting of early Devonian and older rocks. The southward dipping rocks were subaerially eroded, and in most of north-central Oklahoma the early Devonian and older rocks were totally or partially removed.

Although the Nemaha uplift, to the east of VAFB and trending north-south, was not developed until Pennsylvanian and early Permian time, a minor positive element may have been present along a part of the Nemaha trend as early as late Devonian time.

In Pennsylvanian time, the trough of the Wichita basin was compressed into west-northwest and east-southeast trending fault blocks and folds in southern Oklahoma. Just north of the uplifted Wichita Mountains, there lay an area in which continued subsidence occurred. This area later developed into an asymmetric intracontinental geosyncline or basin (Anadarko basin) in which great masses of coarse clastics eroded from adjacent uplifts were deposited, reworked, and spread as conglomerates, sandstones, and shales by marine waters.

During the early phases of this orogenic activity in southern Oklahoma, other portions of the mid-continent region were elevated. Structures along the Nemaha uplift became prominent positive features, causing folding and faulting of Mississippian and older rocks. In the vicinity of VAFB, these pre-Pennsylvanian rocks were elevated and tilted gently to the south and west.

At the end of the Pennsylvanian period gentle elevating movements of regional extent occurred. More or less continuous deposition probably occurred in the VAFB area at the same time erosion was taking place in parts of Kansas. Where these movements succeeded in elevating the sea floor above sea level, subaerial and wave erosion cut into the uplifted Pennsylvanian rocks.

By the beginning of middle Permian time, land barriers probably caused the marine water covering much of the mid-continent region to be restricted from time to time, and with restriction came evaporation and subsequent deposition of anhydrite beds. In the remaining Permian time, environments varied from shallow marine waters to brackish and continental conditions.

Marine transgressions and regressions occurred, but with each succeeding transgression the area inundated by marine waters grew more limited, until finally, continental conditions prevailed and Permian sedimentation was brought to an end.

Little can be said of Mesozoic or early Cenozoic deposits which may have been deposited over the area, for all traces of rocks of these ages have been removed by erosion.

Stream alluvium and terrace deposits were locally deposited in the Quaternary and rest on the eroded, gently westward dipping Permian bedrock of western Garfield County.

Structural and Stratigraphic Relations

VAFB - VAFB is located in the zone of intersection of the northern shelf of the Anadarko basin and the Nemaha uplift. The northern basin shelf is a structural platform of gently undulating surface that is tilted slightly to the south-southwest. Generally, regional dip on shallow subsurface beds is a few tens of feet per mile, increasing to approximately one degree on lower strata. Structural contour lines drawn on subsurface beds indicate that a west-northwest and east-southeast strike prevails over most of the shelf area. However, moving eastward along the shelf near VAFB the strike of the subsurface beds changes rather abruptly to essentially a north-south direction. This change in direction of strike is brought about by the narrow belt of related anticlinal structures which are the southern extension of the Nemaha uplift, which marks the eastern limit of the northern basin shelf. Recent earthquakes indicate that the Nemaha uplift is still active (MacLachlan, n.d.).

The stratigraphic units encountered in north-central Oklahoma are listed in Table 3.3-1. The regional stratigraphic column includes rocks of Quaternary, Tertiary, Cretaceous, Paleozoic, and Precambrian age. Rocks of all Paleozoic eras are represented.

As opposed to the trough of the Anadarko Basin, where continued subsidence occurred over long periods of time and great thicknesses of Pennsylvanian and Permian rocks accumulated, the northern basin shelf was a relatively stable structural feature during middle and late Paleozoic time. The shelf subsided discontinuously to receive mainly the thin platform correlatives of sediments being deposited along the basin trough. A north-south cross section in the vicinity of VAFB and KAux, showing the southward dipping strata, is presented in Fig. 3.3-1.

As shown on the geologic map (Fig. 3.3-2), VAFB is underlain by the Bison Formation of Permian age. The Bison Formation is mainly red-brown shale and greenish-gray and orange-brown calcitic siltstone with minor sandstone (Bingham and Bergman, 1980). It is typically about 120 feet in thickness.

KAux - KAux is situated on Quaternary terrace deposits. These are lenticular and interfingering deposits of light-tan to gray gravel, sand, silt, clay, and volcanic ash. Sand dunes are common features in these deposits. Thickness ranges up to 150 feet and averages about 60 feet.

The Quaternary terrace deposits in the vicinity of KAux overlie the Salt Plains and Kingman Formations, both of Permian age. Where it occurs, the Salt Plains Formation is underlain by the Kingman Formation. The Salt Plains Formation is an orange-brown fine-grained sandstone and siltstone with a greenish-gray sandstone in the middle 30 feet. The thickness ranges up to 160 feet.

The Kingman Formation is an orange-brown to greenish-gray fine-grained sandstone and siltstone with some red-brown shale. Thickness is about 70 feet.

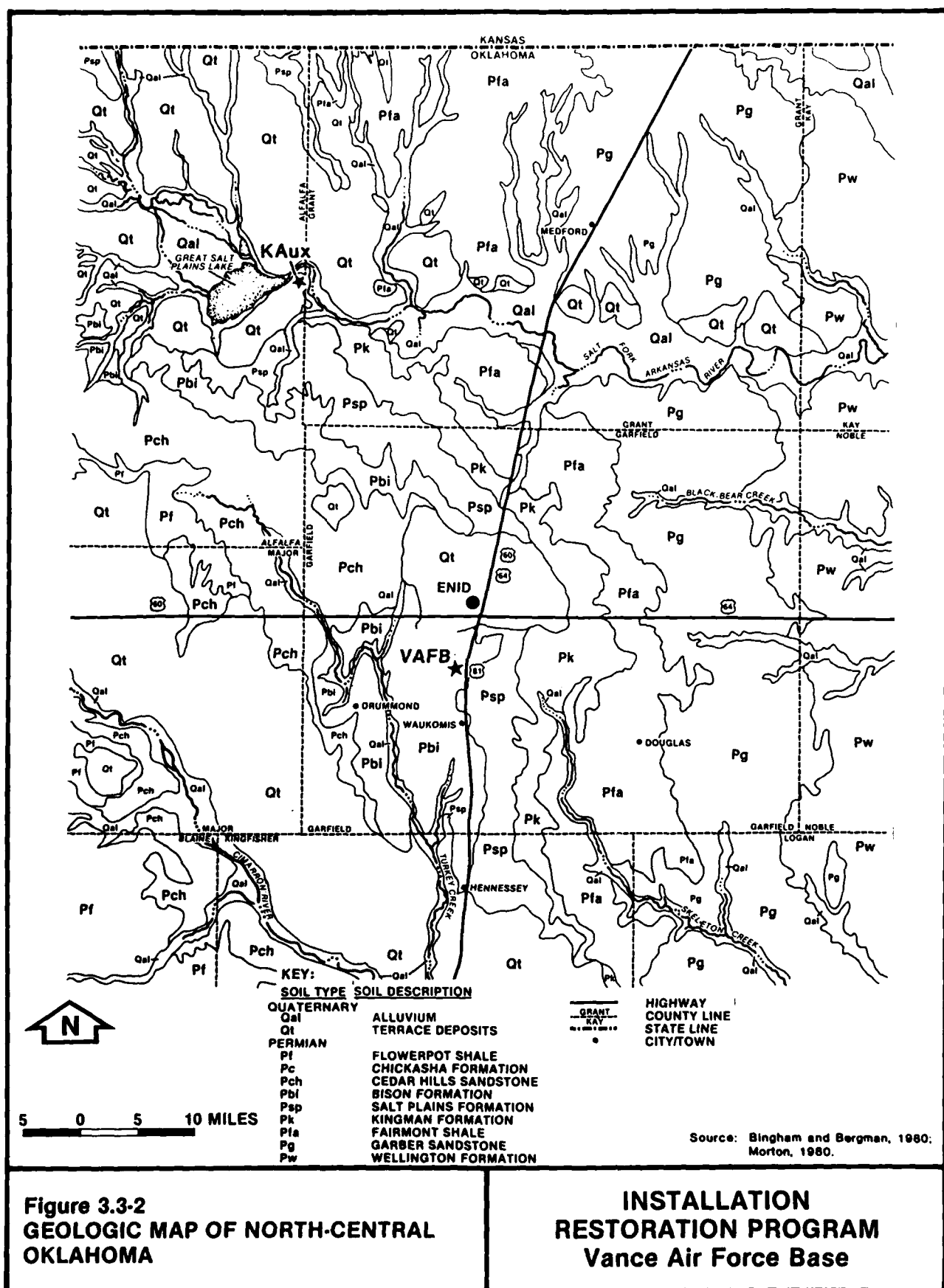
The outcrop patterns of Pennsylvanian and Permian rocks in northern Oklahoma were approximately the same in Jurassic time as they are today.

Table 3.3-1 - Generalized List of Stratigraphic Units of
North-Central Oklahoma. (Page 1 of 2)

System	Series	Group	Formation
Quaternary	Holocene		Alluvium
	Pleistocene		Terrace Deposits
Tertiary	Pliocene		Ogallala Formation
Cretaceous	Comanchean		Kiowa Formation
			Doxey Formation
	Custerian	Foss	Cloud Chief Formation
			Rush Springs Formation
		Whitehorse	Marlow Formation
			Dog Creek Shale
	Permian	El Reno	Blaine Formation
			Flowerpot Shale
			Cedar Hills Sandstone
			Bison Formation
		Cimarronian	Salt Plains Formation
			Kingman Formation
			Fairmont Shale
		Hennessey	Garber Sandstone
		Sumner	Wellington Formation
			Herington Limestone
Pennsylvanian	Gearyan	Oscar	Winfield Limestone
			Fort Riley Limestone
			Wreford Limestone
			Funston Limestone
			Crouse Limestone
			Cottonwood Limestone
			Eskridge Shale
			Neva Limestone
		Vanoss	Sallyards Limestone
			Roca Shale
			Red Eagle Limestone
			Johnson Shale
			Foraker Limestone
			Hughes Creek Shale
			Five Point Limestone
			Admire Sandstone
			Brownville Limestone
			Grayhorse Limestone
			Reading Limestone
	Virgilian	Ada	Auburn Shale
			Bird Creek Limestone
			Turkey Run Limestone
			Little Hominy Limestone
			Deer Creek Limestone
			Lecompton Limestone

Table 3.3-1 - Generalized List of Stratigraphic Units of
North-Central Oklahoma. (Page 2 of 2)

System	Series	Group	Formation
Pennsylvanian	Missourian	Vamoosa	Elgin Sandstone
			Oread Limestone
			Boley Conglomerate
		Ochelata	Tallant Formation
			Barnsdall Formation
			Wann Formation
			Iola Limestone
			Chanute Formation
			Dewey Formation
		Skiatook	Nellie Bly Formation
			Hogshooter Limestone
			Coffeyville Formation
			Checkerboard Limestone
	Desmoinesian	Marmaton	Holdenville Formation
			Oologah Formation
			Labette Shale
		Cabaniss	Fort Scott Limestone
			Wetumka Shale
	Atokan		Calvin Sandstone
			Senora Sandstone
Mississippian	Chesterian Meramecian Osagean Kinderhookian	Morrowan	Dornick Hills Formation (upper)
			Dornick Hills Formation (lower)
			Springer Formation
Devonian and Mississippian			Woodford Shale
Silurian and Devonian		Hunton	
Ordovician		Simpson	Sylvan Shale
			Viola Limestone
			Bromide Formation
Cambrian and Ordovician		Arbuckle	
Cambrian		Timbered Hills	
Precambrian			Metamorphic and Igneous Rocks
Sources:	Naff, 1981 Bingham and Bergman, 1980 Johnson, et al., 1979 MacLachlan, n.d.		



Therefore, the slight westward dip these rocks have on the surface was imparted during post-Permian pre-early Mesozoic time. This gentle westward dip has been referred to as the Prairie Plains homocline.

3.3.2 SOILS

Generally, the soils at VAFB are fine sandy loams with medium fertility, gently rolling and well-drained. Many of these soil series contain clay layers 2 to 4 feet below the surface. These layers are generally discontinuous and do not constitute an aquiclude. Soils associations are shown in Fig. 3.3-3. The five series represented can be briefly described as follows (USSCS, 1967):

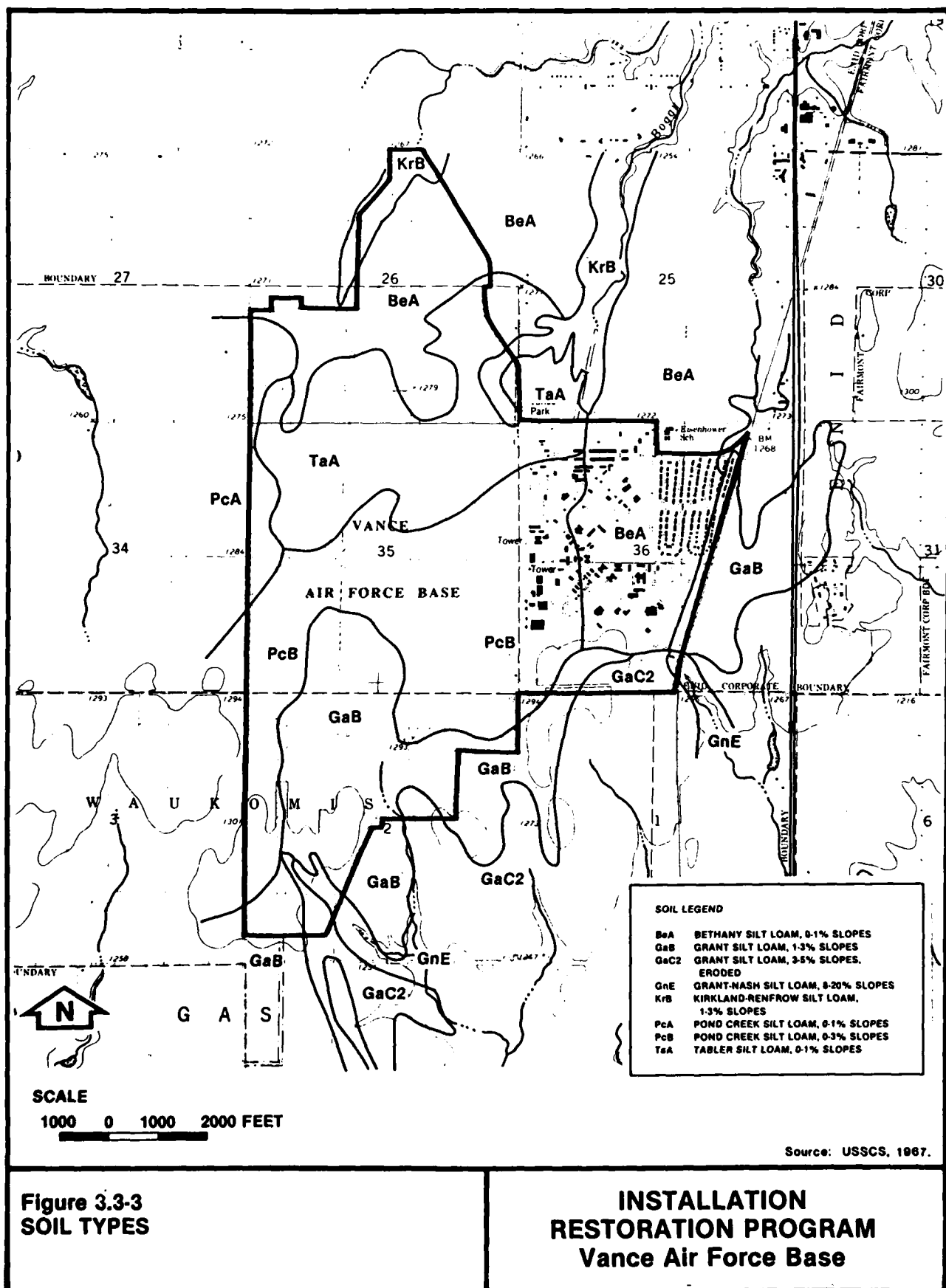
Bethany: This series consists of deep, medium-textured, and nearly level upland soils. The surface layer is a moderately permeable (0.8 to 2.5 in/hr) silt loam. The subsoil is a mildly alkaline clay 24 to 36 inches thick.

Pond Creek: In this series are very fertile, well-drained soils with a moderately to slowly permeable (0.05 to 0.8 in/hr) subsoil. These soils are nearly level to very gentle slopes on uplands, primarily west of the base. The surface layer is a granular silt loam 12 to 16 inches thick, underlain by a silty clay loam about 34 inches thick.

Tabler: Found in nearly level areas and slight upland depressions. These soils consist of a moderately well-drained surface layer of silt loam about 8 in thick. The permeable surface layer is underlain by a transition layer of heavy silt loam 2 to 4 inches thick, which is in turn underlain by a clayey subsoil about 36 inches thick.

Grant: These soils are nearly level to moderately steep and have a 16-inch surface layer of moderately permeable silt loam. Subsoils are about 31 inches thick, consisting of porous to moderately permeable silt loam or light clay loam.

Kirkland: These are nearly level to very gently sloping upland soils with a surface layer of granular silt loam generally about 12 inches thick. The



subsoil is a very slowly permeable (less than 0.05 in/hr), blocky clay about 32 inches thick which is extremely hard when dry. Internal drainage of these soils is very slow.

Soils at KAux vary from those at VAFB, reflecting the different geomorphic settings. The primary soil series at KAux are briefly described below and are mapped in USSCS (1975):

Albion: Soils in this series consist of nearly level through moderately steep, well-drained and somewhat excessively well-drained uplands. The surface layer is a sandy loam about 8 inches thick. Subsoils extend to a depth of about 32 inches and consist of sandy loam with moderately rapid (2.5 to 5.0 in/hr) permeability.

Pratt: These are nearly level to sloping, well drained soils on uplands. The surface layer is a loamy fine sand about 9 inches thick. The subsoil is a loamy fine sand with rapid permeability (5.0 to 10.0 in/hr), which extends to a depth of about 42 inches.

3.3.3 GEOHYDROLOGY

Precipitation is the source of nearly all ground water in the vicinity of VAFB. Although winter is the driest season, most ground water recharge occurs from November to April when evaporation and transpiration are at a minimum. Ground water recharge to the Cimarron terrace southwest of VAFB has been estimated to be 14.5 percent of the average annual precipitation (Bingham and Bergman, 1980). Recharge to other terrace deposits and to alluvium in the vicinity of VAFB may be about the same amount because the surface soils are sandy and capable of absorbing large amounts of water and because the lithologies of the aquifers are similar.

Amounts of recharge to bedrock aquifers are unknown but undoubtedly are considerably less than recharge to terrace deposits and alluvium. The amount of water that can enter the soil and percolate downward to the underlying bedrock is limited because soils in the recharge area of the bedrock generally consist mostly of clay which has low permeability.

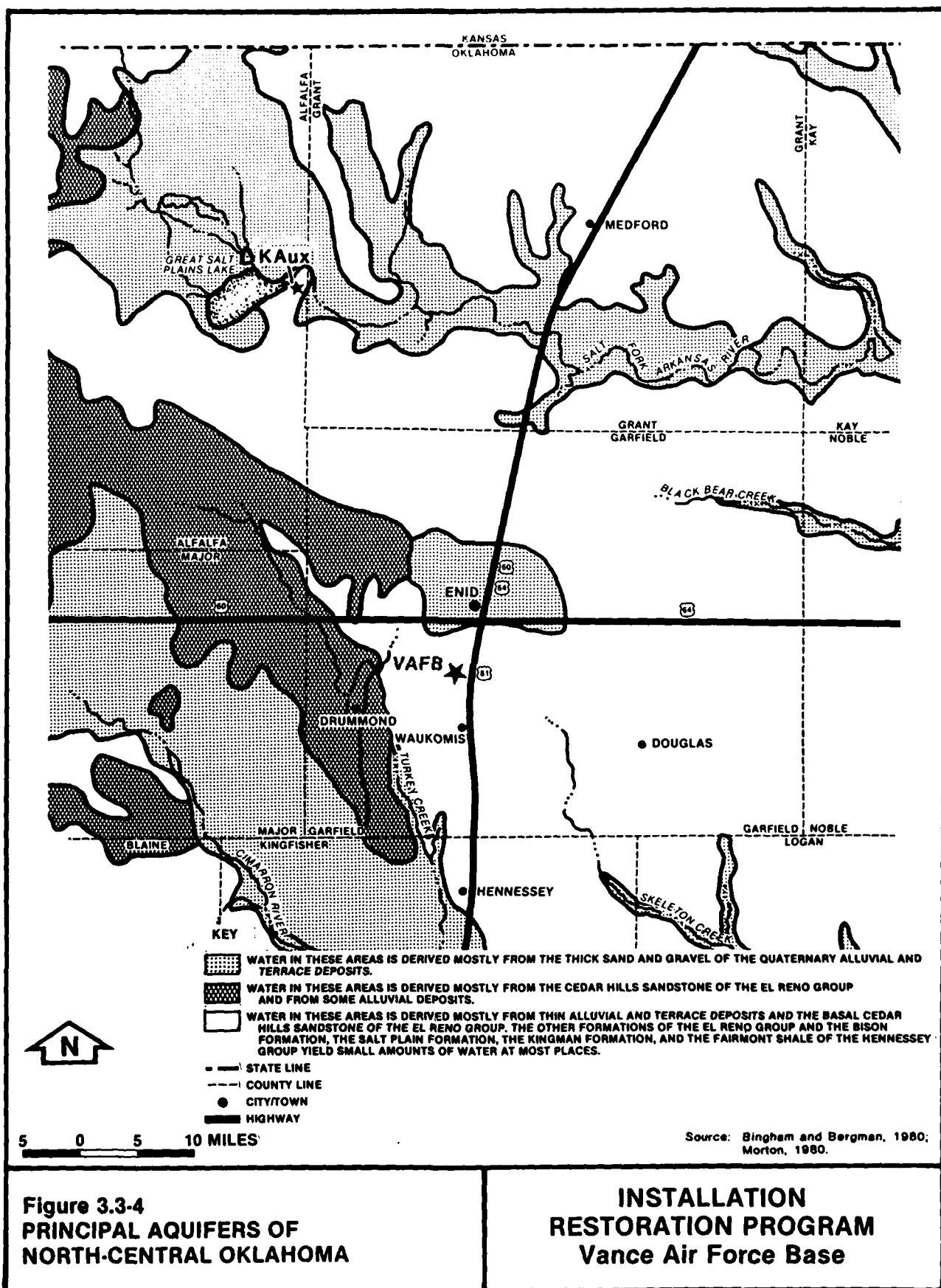
Ground water movement generally is from the uplands towards the streams. Seepage to the streams and evapotranspiration account for most of the ground water discharge. During dry periods, seepage from the aquifers is the source of base flow in the streams. Small streams in the area frequently go dry because the fine-grained sandstone and shale underlying the area have a limited capacity to absorb and transmit ground water.

Along the major streams the alluvium is thick enough to absorb and transmit large amounts of water, maintaining base flow in the major streams. During wet periods, however, when the stream level is higher than the water table in the adjacent alluvium, seepage from the stream through the stream bank is a source of recharge to the alluvium.

Two principal aquifers are recognized in the VAFB area: the alluvial aquifer and the Cedar Hills aquifer. The approximate distribution of the aquifers is illustrated in Fig. 3.3-4.

The alluvial aquifer includes both alluvial and terrace deposits and is composed of silt, clay, and fine sand with coarse sand and gravel at the base in some areas. The alluvial aquifer located along minor seams is composed of fine-grained sand containing varying amounts of silt and clay; thus, the permeability is generally low. Well yields in the alluvial aquifer range from 50 to 600 gallons per minute (gpm) in river and terrace deposits to 25 to 50 gpm in areas adjacent to minor streams. Enid obtains its water from terrace deposits which surround the city and from alluvial and terrace deposits adjacent to the Cimarron River.

Aquifers in the bedrock are composed of saturated sandstone layers irregularly interbedded with shale, siltstone, and limestone. Most of the sandstone layers are fine-grained, thin, and commonly yield only enough water for household use. Locally, however, part of the sandstone is medium- to coarse-grained and yields as much as 200 gpm to industrial, irrigation, and public-supply wells. The Cedar Hills aquifer, the bedrock aquifer nearest VAFB, is mostly fine-grained sandstone interbedded with siltstone and shale. The potential well yields are estimated at 150 to 200 gpm.



The remainder of the area, including VAFB itself, is underlain by minor local aquifers. Ground water occurs in strata that are predominantly shale with some siltstone and fine-grained sandstone. Recharge is from local precipitation and well yields are small, typically 3 to 10 gpm. Waukomis obtains a portion of its municipal water from nine wells located three miles south-southwest of VAFB. The wells are 60 feet deep and have yields of approximately 25 gpm. These wells provide water to 1500 persons.

Soil borings at VAFB shown in Fig. 3.3-5 indicate that in the vicinity of Bldg. 672 water occurs in an orange, silty clay at depths of 6 to 13.5 feet (VAFB, 1982). Bedrock at these locations is described as an orange, silty shale and is found at depths of 10 to 13.5 feet. In one boring, located at the north corner of Bldg. 672, water was found in a clayey silt stratum at a depth of 2 to 3 feet.

At Bldgs. 690 and 810, east of Bldg. 672, bedrock was encountered at depths of 11 to 18 feet without any water-bearing strata identified in the overlying unconsolidated materials. The bedrock was described as a sandy clay-shale in the vicinity of Bldg. 690 and a reddish-brown, fine-grained, silty, clayey, shaley sandstone at Bldg. 810.

Near Bldg. 410, a wet stratum was found at a depth of 9 to 22 feet and bedrock (red shale) was encountered at 20 to 23 feet.

The occurrence of ground water at VAFB appears to be highly variable and in low-permeability strata. The available data are not sufficient to determine direction and rates of ground water movement.

KAux, while not underlain by a principal aquifer, is adjacent to the Salt Fork alluvial aquifer. The deposits along the Salt Fork River attain a maximum thickness of approximately 60 feet with a maximum saturated thickness of about 35 feet (Vance, 1976).

3.4 WATER QUALITY

3.4.1 SURFACE WATER

VAFB is drained by small intermittent streams. Surface water quality monitoring has been restricted to the STP effluent, the north drainage ditch

(Boggy Creek) below the STP discharge point and the south drainage ditch (Hackberry Creek). Both drainage ditches are sampled near the base boundary. The locations of these sampling points are shown in Fig. 3.2-1.

Water quality data for these stations are summarized in Table 3.4-1. The compliance standards shown in Table 3.4-1 are obtained from Oklahoma Water Resources Board Permit No. WD-79-021, which currently regulates water quality at the three VAFB sampling points.

The data indicate that concentrations phosphorus in the STP effluent often exceed compliance standards and that phenols and chromium concentrations are occasionally in excess of standards. The north drainage ditch water quality is greatly influenced by the STP effluent, which at times comprises the majority of the flow in the ditch. Phosphorus concentrations in the ditch exceed the compliance standards, and the chemical oxygen demand is higher than would be expected in most streams.

The south drainage ditch is often dry and has been sampled on only two occasions. In both instances, the oil and grease concentrations were relatively low.

The available water quality data are somewhat limited in parametric coverage and do not eliminate the possibility of contamination existing to an undesirable extent. For example, the oil and grease analyses in the drainage ditches would not detect low-level, but potentially toxic, releases of trace halogenated or nonhalogenated organics or polychlorinated biphenyls (PCBs).

The small streams draining KAux have not been characterized with respect to water quality. The Salt Fork, adjacent to KAux and the receiving water body for streams draining KAux, reportedly has poor water quality due to high dissolved solids concentrations (Morton, 1980).

Table 3.4-1. Water Quality Data for Surface Waters and Discharges for VAFB.

Station/Parameters	Compliance Standard mg/l	Concentration, mg/l					
		1983			1984		
		No. of Samples	Min.	Max.	Mean	No. of Samples	Min. Max. Mean
STP Effluent							
Cyanide	0.025	7	<0.01	0.03	<0.01	5	<0.01 0.02 <0.01
Phenols	0.2	8	<0.01	0.98	0.13	5	<0.03 0.98 0.31
Arsenic	0.2	6	<0.01	<0.01	<0.01	5	<0.01 <0.01 <0.01
Cadmium	0.03	8	<0.01	<0.01	<0.01	5	<0.01 <0.01 <0.01
Chromium	0.1	8	<0.05	0.23	0.06	5	<0.05 0.11 0.08
Copper		2	0.07	0.09	0.08	5	0.04 0.103 0.07
Lead	0.1	8	<0.02	0.06	0.02	5	<0.02 <0.02 <0.02
Phosphorus	1.0	11	0.8	11.0	6.3	9	5.9 14.75 9.6
Methylene chloride		4	n.d.	0.23	0.08	7	0.054 0.196 0.14
North Drainage Ditch							
Oils and grease	Avg.-15 Max.-20	10	0.8	10.1	3.2	5	0.4 7.8 4.3
Chemical oxygen demand							
Phosphorus	1	9	25	300	115	9	35 225 110
Lead	0.1	9	4.0	6.5	5.5	9	2.9 9.75 6.7
		9	<0.02	<0.05	<0.02	9	<0.02 <0.03 <0.02
South Drainage Ditch							
Oils and grease		2	<0.3	0.5	0.32	0	— — —

n.d. - not detected

Source: VAFB BES, 1984

3.4.2 GROUND WATER

Due to the absence of wells on VAFB and KAux, the quality of ground water beneath the installation has not been characterized. Some information regarding the general characteristics of ground water in the vicinity of VAFB can be obtained using data from adjacent areas, however. The discussion of ground water quality provided in the following paragraphs was obtained from Bingham and Bergman (1980). Locations of wells from which ground water quality data were obtained were not provided.

Chemical characteristics of ground water in the Enid area differ considerably within short distances. In general, the water is hard or very hard and locally contains sulfate and chloride in excess of 250 milligrams per liter (mg/l). Samples of water from some shallow wells contain more than 45 mg/l nitrate. The dissolved solids concentrations of water samples range from 60 to 6,000 mg/l and average about 650 mg/l.

Sulfate in ground water is derived from such minerals as gypsum and anhydrite (calcium sulfate). Chloride is derived from halite (sodium chloride) and brines and from human, animal, and industrial wastes. Small amounts of chloride have little effect on the usability of water for most purposes; however, water containing chloride in concentrations of several hundred milligrams per liter has a salty taste.

Nitrate in water is considered to be a final oxidation product of nitrogenous material, and when present in concentrations greater than about 45 mg/l may indicate contamination by sewage and other organic matter. Chemical fertilizers also may be a source of nitrate. The quantity of nitrate present in natural, unpolluted water generally is only a few milligrams per liter.

Calcium is dissolved from many rocks, but higher concentrations generally are found in water that has been in contact with limestone (calcium carbonate), dolomite (calcium magnesium carbonate), or gypsum; magnesium is dissolved primarily from dolomitic rocks. Both calcium and magnesium contribute to the water's hardness, which reduces the cleaning action of soap and detergents and which has scale-forming properties.

Dissolved solids consist principally of dissolved minerals and organic matter in the water. A dissolved solids concentration of 500 mg/l is considered the recommended upper limit for drinking water and for most domestic and industrial uses.

Some mineralization of ground water in the vicinity of VAFB might be due to contamination by oil-well brines, particularly in the vicinity of oil fields. Such contamination may be the result of seepage from waste pits, defective well casing, defective well plugging, water-flooding operations, or improper brine disposal.

The Garfield County Health Department has not received any reports of ground water quality complaints other than excessive hardness and chloride concentrations.

The total population within 3 miles of VAFB using local ground water as a potable water source was estimated to be less than 50 south and east of the installation and between 50 and 1000 north and west of the base.

Potable water for VAFB is obtained from the City of Enid, and KAux potable water is obtained from a well north of KAux. Samples of both water sources have been analyzed and found to be in compliance with National Interim Primary Drinking Water Regulation (NIPDWR) standards.

3.5 BIOTA

VAFB is located in the central rolling red plains region of Oklahoma. No areas of undisturbed vegetation remain on the base. Dominant vegetation are grasses, chiefly Bermuda grass and rye grass. Principal tree species are honey locust, cottonwoods, and several species of conifers. Prairie areas on VAFB include a mixture of native and introduced species such as Bermuda grass, weeping love buffalo grass, blue stem, rye, blue grama grass, and dropseed.

Wildlife activity on VAFB is limited due to small amounts of suitable habitat and by high levels of human activity. Mammals which inhabit the base

include cottontail rabbit, blacktail jackrabbit, badger, striped skunk, coyote, racoon, and deer mice. Meadowlarks are common. Reptiles which occur on the base are the bullsnake, western hognose snake, and several species of lizards.

No threatened or endangered species regularly inhabit the area. The southern bald eagle, whooping crane, and American peregrine falcon have been observed in the vicinity of VAFB, but suitable habitat does not exist on base for any of these species.

Habitats in the KAux area include willow, cottonwood, and black locust woodlands interspersed with prairie grasslands. Wildlife include whitetail deer, racoon, striped skunk, eastern fox squirrel, bobcat, coyote, badger, opossum, crow, pheasant, mourning dove, turkey, and several species of quail. The availability of suitable habitat and the proximity to water on KAux account for the greater variety of wildlife found there. In addition to the southern bald eagle, whooping crane, and American peregrine falcon, additional threatened or endangered species observed in the vicinity of KAux are the prairie falcon, golden eagle, sandhill crane, and blacktail prairie dog.

In addition to the principal species indicated above, both VAFB and KAux are host to a larger number of other migratory and resident wildlife species.

Located north of KAux is the Great Salt Plains National Wildlife Refuge. This refuge provides habitat for many wildlife species.

4.0 FINDINGS

This chapter presents information for VAFB on wastes generated by activity, describes past waste disposal methods, identifies the disposal and spill sites located on the base, and evaluates the potential for environmental contamination. This information was obtained by a review of files and records, interviews with present and former Air Force and base employees, and site inspections.

4.1 ACTIVITY REVIEW

4.1.1 INDUSTRIAL OPERATIONS

All the major current and past industrial operations at VAFB relate to the maintenance of the aircraft used in pilot training. The different levels of maintenance and the various operations are conducted by several different organizations at a number of locations on the base. Operations include engine repairs/overhauls; electrical, hydraulic, and fuel system repairs; painting; metal plating/finishing; and support equipment maintenance. No industrial activities are conducted at KAux.

The basic mission of VAFB has remained essentially the same since the base was first activated. However, over that period the type of aircraft being flown has changed several times. Between 1942 and 1956, propeller-driven aircraft were used. These were followed by the T-33 between 1956 and 1960. The T-37 was introduced in 1960 and was joined by the T-38 in 1964. The materials, construction, and maintenance requirements of these earlier aircraft differed from those currently in use. Thus, the specific equipment and materials used in current maintenance operations may not reflect the 10 years prior to 1960, although the categories of maintenance being performed and locations where they are conducted have changed little.

Scheduled maintenance, including oil and fluids changes and other routine items, is performed in the T-37 and T-38 maintenance shops located in Bldgs. 195 and 141, respectively. Heavy and nonscheduled maintenance for both aircraft is performed in a separate facility at Bldg. 129. Engines

requiring major repair or overhaul are removed from the aircraft and taken to Bldg. 187, which is equipped with facilities and equipment for such operations. Painting of parts is conducted in the Bldg. 128 paint shop, while the aircraft are painted in Bldg. 192, and motor vehicle painting is done in Bldg. 298. All these locations are equipped with liquid curtain spray booths, and Bldg. 192 is specially fitted to accommodate the large scale stripping operation required for complete aircraft repainting. Metal treatment operations are conducted in the plating shop at Bldg. 128, and in Bldg. 187, the jet engine shop.

Other training activities at VAFB in addition to pilot training include firefighter training. Fire training exercises are conducted regularly using JP4 as fuel and using water and AFFF as suppressants. The KAux fire unit conducts similar exercises at the KAux firefighter training area in an unlined pit approximately twice a year.

4.1.2 FUELS/OILS HANDLING AND STORAGE

The main fuel used at VAFB is JP4 jet fuel. Additional fuels and oils stored and used in quantity are gasoline (MOGAS), diesel fuel, and 7808 engine oil. The largest storage points are Tanks 265 and 267, both located adjacent to the west gate. These tanks provide above ground storage of JP4 and normally contain a combined quantity of 605,000 gallons (gal). Secondary containment at this location is provided by an asphalt-sealed earthen berm enclosing an unlined area. Various underground tanks ranging in capacity from 3,000 to 25,000 gal are used to store the other products (see Table 4.1-1).

Refueling of aircraft is performed on the flight line. Fuel is transported from the storage tanks in tank trucks with capacities of 3,000 to 5,000 gal. On occasions when refueling is required at KAux, fuel is transported in a tank truck from VAFB. Trucks are filled from a transfer point at the north end of the flight line. No secondary containment is provided at this location. All planes on the flight line are normally kept full of fuel. The T-37 holds 309 gal and the T-38 holds 583 gal. Personnel from base fuels

Table 4.1-1. POL Storage Tanks

Tank No.	Capacity (gallons)	Type Above/Below Ground	Contents
265	250,000	AG	JP4
267	675,000	AG	JP4
90-99	10@25,000	BG	empty
87	12,000	BG	MOGAS
88	12,000	BG	MOGAS
106	12,000	BG	Diesel
108	12,000	BG	Solvent
109	12,000	BG	empty
112	12,000	BG	Waste Oil
522	10,000	BG	MOGAS
522	2@4,000	BG	MOGAS
522	3,000	BG	MOGAS

Source: ESE, 1984

operate and maintain the fuel storage and distribution system. Storage tanks, valves, and piping are inspected daily to check for conditions which pose a fire or spill hazard.

4.1.3 PESTICIDE/HERBICIDE HANDLING AND STORAGE

The mixing and bulk storage locations for pesticides/herbicides at VAFB are Bldgs. 255 and 194, respectively. Small containers of some materials are stored in Bldg. 284. Handling, storage, and applications of pesticides and herbicides is carried out in accordance with the VAFB Pest Management Plan and applicable state and federal regulations. There are no stocks of restricted pesticides on hand. Both Silvex and 2,4,5-T were once used on the base, but remaining stocks of these materials were turned in to DPDO when restrictions were imposed.

Waste generation associated with pesticide and herbicide use is limited to empty containers, rinseate and wastewater generated from cleaning spraying equipment. Since 1968, when an entomologist was first assigned to the base, containers have been triple-rinsed and disposed of as solid waste with the rinse water used in subsequent mixing. Until recently, spraying equipment was washed at the wash rack at Bldg. 270. The rack drains to an oil/water separator which is periodically pumped out and the material is drummed for contract disposal. Washing was recently moved to a new facility at Bldg. 255, which drains to the sanitary sewer through a grit trap. Prior to 1968, pesticide/herbicide application was conducted on a limited spot basis, and disposal procedures are undocumented.

4.1.4 PCB HANDLING AND STORAGE

Analyses have been performed on 93 transformers at VAFB of which 12 were found to contain PCB's at greater than 500 ppm and an additional 20 were found contaminated with PCB's at levels between 50 and 500 ppm. These transformers are currently stored in the hazardous waste storage area north of Bldg. 193. These transformers are part of a group of over 200 which were taken out of service in 1983 during an upgrade of the VAFB electric distribution system. All these units, including 125 which have not been analyzed, will be disposed of through contract off-base.

No record was found of PCB spills or on-base disposal of transformer oil. However, electric shop personnel reported that transformers which required replacement were stored in the Civil Engineering Salvage Yard near the West Gate and were drained onsite before being turned over to DPDO. This oil may have been disposed of by mixing with other waste oil generated, but this procedure was not documented.

4.2 HAZARDOUS WASTE GENERATION/DISPOSAL

4.2.1 GENERATING OPERATIONS

VAFB engineering personnel provided a hazardous waste inventory conducted in June 1980. This listing was used as the basis for identifying shops on the base and making a preliminary assessment of the types and quantities of waste generated by the various operations. Interviews were conducted with personnel from each of the major waste generation points. Telephone contacts were made with smaller operations. In each interview, personnel were asked to verify or update the types and quantities of waste generated as reported in the 1980 survey. By locating personnel who had long employment histories, information was obtained on how waste generation patterns had changed over the years. These interviews also provided the information on disposal methods presented in Sec. 4.2.2.

Information obtained on the major waste generating operations is summarized in Table 4.2-1. Not all the wastes listed are hazardous wastes as defined by EPA, but have been included to provide a complete picture of the range and quantity of waste generated which require controlled disposal. A master list of facilities and shops at VAFB and their waste generation status is presented in Appendix D.

The main types of waste generated at VAFB are fuel, oils and solvents, paints and paint strippers, and metal plating/treatment solutions. Waste fuel, oil and solvents include JP4, engine oil, PD680, and acetone, which are derived primarily from periodic maintenance and engine repair operations, but are generated in small quantities at almost all the maintenance shops. Waste consisting of paint residue, strippers and thinner is generated by the parts, aircraft, and vehicle painting operations. The aircraft painting operation, which is one of the largest waste generators on the base, was

Table 4.2-1 - Waste Generation and Disposal. (Page 1 of 4)

Shop Name	Location Present	Waste Material	Waste Quantity	Methods Treatment, Storage, and Disposal				
				1950	1960	1970	1980	
Base Fuels	116	Tank cleaning sludge	420 gal/yr	Landfill				
T-38 Maintenance	141	Trichloroethane	550 gal/yr	FTA	Tank	CD		
		JP4	165 gal/yr	FTA	CD/FTA			
		7808 oil	220 gal/yr	FTA	CD			
		Neutralized Battery Acid	15 gal/yr		SS			
Metal Plating	128	Hydraulic fluid	550 gal/yr	SS	CD			
		Cadmium solution (including sodium cyanide, cadmium oxide, sodium carbonate, sodium hydroxide)	400 gal/yr	Landfill CDP	Tank	CD		
Electric KEY	128	Chromic acid solution (including chromic acid, sulphuric acid, ammonium nitrate, and hydrochloric acid)	400 gal/yr	Landfill CDP	Tank	CD		
		Rinse water	390 gal/yr		SS			
		Acetone	45 gal/yr	FTA	Tank	CD		

Data confirmed by Shop Personnel.
 Estimated from Secondary Sources.
 FTA - Firefighter Training Area.
 CDP - Chemical Disposal Pits.
 CD - Contract Disposal via DPDO or service
 contract for Recycling.

Tank - Held in Underground Holding Tank
 Pending Contract Disposal.
 Landfill - Buried in/on Base Landfill.
 SS - Sanitary Sewer.

Table 4.2-1 - Waste Generation and Disposal. (Page 2 of 4)

Shop Name	Location		Waste Material	Waste Quantity	Methods			
	Present	Past			1950	1960	1970	1980
Oil Analysis (SOAP) Lab	130		Oil 7808	4 gal/mo		FTA		CD
Precision Measurement (PMEL)	128		Mercury Sulfuric acid	13 lbs/yr <1 gal/yr		Landfill/SS		CD SS
Battery Repair	128		Neutralized Battery Acid	15 gal/yr			SS	
Support Equipment (AGE)	126		Motor oil 10W40 Oil 7808 Hydraulic fluid	18 gal/mo 5 gal/mo 23 gal/mo		Landfill/FTA Landfill/FTA SS/Landfill		CD CD CD
Nondestructive Inspection (NDI)	130	129	Penetrant	55 gal/yr				CD
			Emulsifier	110 gal/yr				CD
			Developer	40 gal/yr				SS
			Fixer	60 gal/yr				SS
			Napthalene	50 gal/yr				CD
Paint (Aircraft)	128		Acetone	1100 gal/yr		FTA		Tank CD
			Paint residue	4 gal/mo		Landfill		Tank CD
			Stripper residue	1 gal/mo		Landfill		Tank CD
			Spray booth wastewater	1100 gal/mo			SS	

KEY

_____ Data confirmed by Shop Personnel.
 _____ Estimated from Secondary Sources.
 FTA - Firefighter Training Area.
 CDP - Chemical Disposal Pits.
 CD - Contract Disposal via DPDO or service contract for Recycling.

Tank - Held in Underground Holding Tank
 Pending Contract Disposal.
 Landfill - Buried in/on Base Landfill.
 SS - Sanitary Sewer.

Table 4.2-1 - Waste Generation and Disposal. (Page 3 of 4)

Shop Name	Location Present	Past	Waste Material	Waste Quantity	Methods			
					Treatment, Storage, and Disposal 1950	1960	1970	1980
Machine	128		Cooling oil Acetone	25 gal/yr 10 gal/yr	FTA			CD
					FTA			CD
Carpenter/Paint	274		Paint Residue/ Thinner	110 gal/yr	Landfill/CDP		Tank	CD
Aero Repair (Heavy/nonscheduled maintenance)	129		Hydraulic fluid Oil 7808 JP4	165 gal/yr 110 gal/yr 55 gal/yr	SS/Landfill			CD
					Landfill/FTA			CD
					FTA			FTA/CD
Engine Test Cell	47		Oil 7808 JP4	110 gal/yr 55 gal/yr	FTA			CD
					FTA			FTA/CD
Fuel Cell Maintenance			JP4	1500 gal/yr	FTA			FTA/CD
Tire	170		7808 oil Trichloroethane Hydraulic Fluid	1103 gal/yr 330 gal/yr 55 gal/yr	FTA		Tank	CD
					Landfill/FTA		Tank	CD
					Landfill/CDP		Tank	CD
Wash Rack	170		Alkaline cleaner	220 gal/mo			SS	
Paint Hangar	192	186	Polyurethane Paint Acetone Paint stripper	275 gal/yr 1100 gal/yr 450 gal/mo			Tank	CD
							Tank	CD
							Tank	CD

KEY

_____ Data confirmed by Shop Personnel.
 _____ Estimated from Secondary Sources.

FTA - Firefighter Training Area.

CDP - Chemical Disposal Pits.

CD - Contract Disposal via DPDO or service
 contract for Recycling.

Tank

- Held in Underground Holding Tank

Pending Contract Disposal.

Landfill - Buried in/on Base Landfill.

SS - Sanitary Sewer.

Table 4.2-1 - Waste Generation and Disposal. (Page 4 of 4)

Shop Name	Location		Waste Material	Waste Quantity	Methods			
	Present	Past			1950	1960	1970	1980
T-37 Maintenance	195		7808 oil	550 gal/yr			FTA	CD
			Hydraulic fluid	330 gal/yr			SS	CD
			Acetone	275 gal/yr			FTA	CD
			JP4	110 gal/yr			FTA	FTA/CD
UPI/IFS	672		Hydraulic Fluid	220 gal/yr			FTA	CD
Jet Engine	187	170	7808 oil	385 gal/yr	Landfill/FTA			CD
			Trichloroethane	220 gal/yr		FTA	Tank	CD
			JP4	220 gal/yr		FTA	FTA/	CD
			Phosphoric acid	800 gal/yr		CDP	Tank	CD
			Descaling solution	800 gal/yr		CDP	Tank	CD
			Potassium permanganate					
			Soda ash	800 gal/yr		CDP	Tank	CD
			Sodium hydroxide			CDP	Tank	CD
BX Service Station	522		Motor Oil	900 gal/yr		FTA		CD
Motor Pool	298		Cutting Oil	110 gal/yr	Landfill/CDP		Tank	CD
			Neutralized Battery Acid	55 gal/yr		CDP	Tank	CD
Auto Hobby	301		Motor oil	1200 gal/yr		FTA		CD
			Transmission Fluid	110 gal/yr		FTA		CD
Communications	2110		Electron tubes, compasses	2-30 gal cont/yr			CD	

KEY

Data confirmed by Shop Personnel.
 Estimated from Secondary Sources.
 FTA - Firefighter Training Area.
 CDP - Chemical Disposal Pits.
 CD - Contract Disposal via DPDO or service contract for Recycling.

Source: ESE, 1984.

Tank - Held in Underground Holding Tank
 Pending Contract Disposal.
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begun in 1970, but only reached the current level of activity in 1980 when a program to repaint the entire fleet was initiated. Metal plating/treatment waste is generated at the jet engine shop and metal plating shops and consists of phosphoric acid, chromic acid, potassium permanganate, cadmium, and descaling solutions.

The fire suppressant currently employed at VAFB and KAux is AFFF. Available information suggests that, at least in some applications, carbon tetrachloride may have been employed until approximately the mid-1950s. The use of chlorobromomethane may have followed carbon tetrachloride and may have been utilized until the early 1970s. The extent to which these suppressants were utilized and the manner of their disposal at VAFB and KAux could not be substantiated.

4.2.2 DISPOSAL METHODS

The information obtained on waste disposal practices is summarized graphically in Table 4.2-1. The general trend over the years since VAFB first began operation has been from largely unsegregated disposal in base landfills toward extensive waste segregation and contract disposal. Prior to 1960, it was reported that virtually no waste segregation was practiced, and containerized liquids from industrial operations were routinely buried in base landfills. However, over this same period, the firefighter training area was used as a general disposal area for fuel, oil, and solvents, so it is doubtful that much of this material ever reached the landfills. Also, most burnable trash was incinerated on base, and some edible garbage was sold as hog feed to local farmers. Information from this early period is difficult to substantiate. It is likely that small quantities of liquids were disposed of in the sewers or dumped on surface soils.

By the early 1960's, the practice of digging dedicated pits for disposal of some industrial waste was in use. The material disposed of in this manner reportedly consisted mainly of metal plating solutions and sludges from fuel tank cleaning, but may also have included other industrial liquids and infectious waste from the base hospital. While landfilling of solid waste and trash incineration on the base were discontinued by 1965, disposal pits were reportedly used until approximately 1970.

Waste disposal practices at VAFB changed substantially in the early 1970's. Collection of waste fuel, oils, and solvents for contract reclamation off-base was initiated, and the current system for contract disposal of unusable quantities began. Flammable liquids used in fire training was restricted to JP4 only, and existing lined firefighter training pit was constructed. The practice of using pits for chemical and sludge disposal was replaced by a system where these materials were stored in an unused underground fuel tank near Bldg. 110 and eventually removed for contract disposal.

By approximately 1980, the present system for chemical and sludge disposal eliminated the need for temporary storage in the underground tank. Wastes are containerized in 55-gal drums, labeled according to DOT and EPA regulations, and held at the fenced accumulation point north of Bldg. 122 for contract disposal. Ultimate disposal is arranged through VAFB's designated DPDO at Tinker AFB, Oklahoma. Industrial waste disposal on the base is now limited to liquid waste from the paint stripping operation in Bldg. 192, which is metered into the sanitary sewer and processed through the base sewage treatment plant. Sludge from the treatment plant has been analyzed and a Sludge Management Plan is being prepared.

4.2.3 SPILLS OR INCIDENTAL DISCHARGES

The VAFB SPCC plan indicates no record of spills except minor losses during fueling of aircraft. Base fuels personnel confirmed this, reporting no spills requiring emergency response or cleanup efforts.

4.2.4 OFF-BASE DISPOSAL SITES

Available information indicates that materials originating at VAFB are currently directed to three disposal sites. Solid waste is transported to the City of Enid landfill through a local contract. Hazardous and liquid waste are disposed of through arrangement with Tinker AFB DPDO. Since 1980, VAFB has contracted with a hazardous waste incinerator in El Dorado, Arkansas; the EPA-permitted hazardous waste landfill at Lone Mountain, Oklahoma; and Chemical Waste Management in Port Arthur, Texas. Before 1980, VAFB contracted for waste disposal at a landfill in Criner, Oklahoma.

and the Conservation Chemical Company landfill in Kansas City, Missouri. Both sites are under study as part of the EPA Superfund program.

4.3 AREAS OF POTENTIAL CONTAMINATION

This study identified eight areas on VAFB subject to contamination by industrial and/or hazardous waste as a result of handling and disposal practices. Figures 4.3-1, 4.3-2, and 4.3-3 illustrate the locations of these areas. Aerial photographs of each site are provided in Appendix E.

Tank Farm Landfill

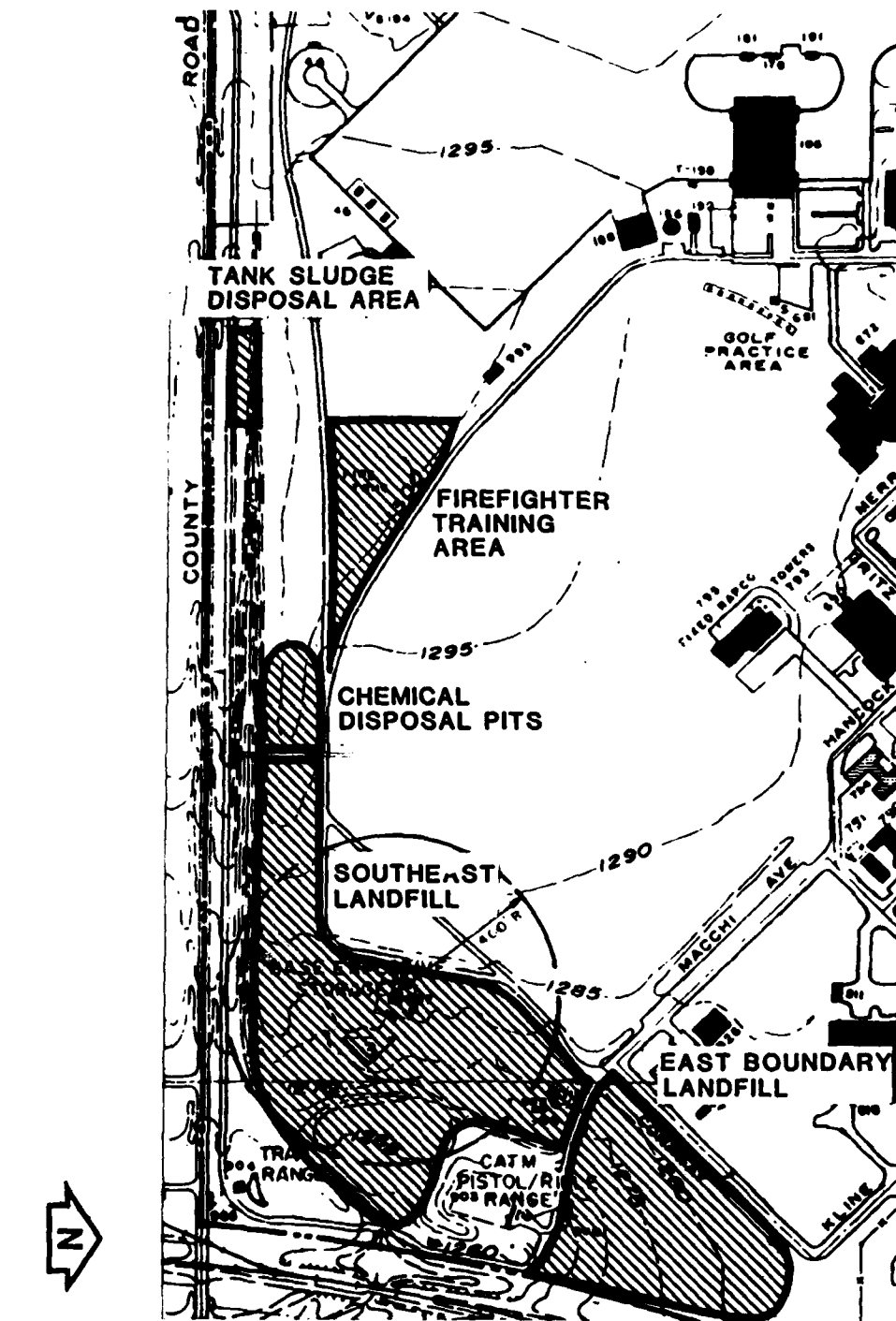
The Tank Farm Landfill site is located on the north base boundary, adjacent to the west gate and the main JP4 storage tanks. This site was used as a general purpose landfill during the years before 1952. The landfill was operated by the trench and fill method, with the trench bottom at a depth of approximately 15 ft. Personnel that operated this site from 1948 to 1951 reported wastes consisted mostly of household solid wastes, but no restrictions were placed on items dumped, and other wastes including containerized liquids were routinely landfilled. It was reported that some tank sludge from leaded gas tanks was buried under the berm around Tank 267 before that facility was constructed. Most of this area is currently open and unused, although the filled area is thought to extend part way under the existing JP4 tanks.

East Boundary Landfill

In approximately 1952, landfilling activities shifted to the East Boundary Landfill located on the east base boundary adjacent to the pistol range and base clinic. This site was operated as a general purpose trench type landfill for approximately five or six years. Material deposited here was predominately household solid waste and possibly industrial liquids. Trenches were dug to approximately 15 ft deep, and waste was covered with the excavated material. This is currently an open area which is cultivated as garden plots by base personnel.

Southeast Landfill

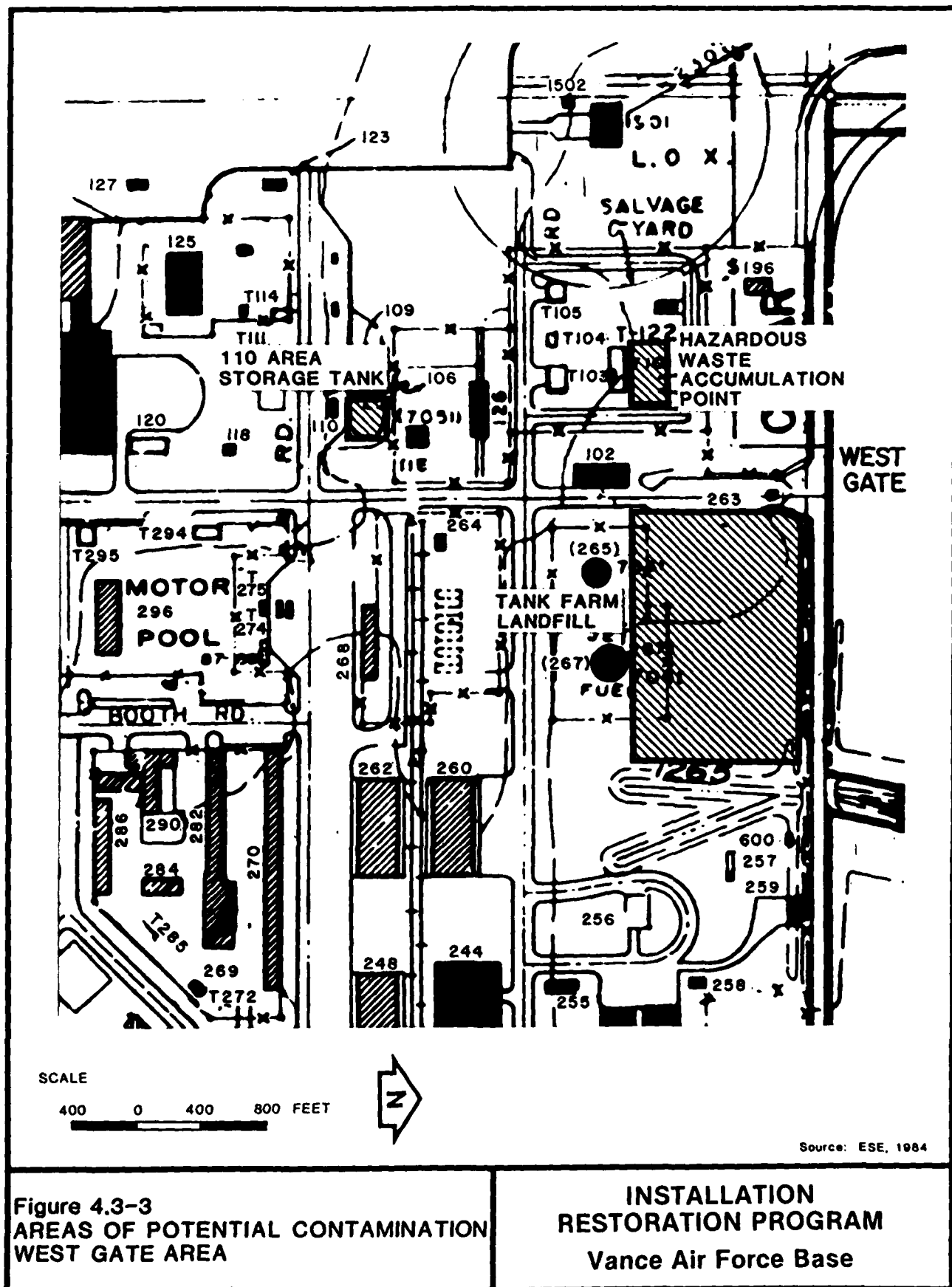
From approximately 1958 to 1965 trench and fill disposal of solid waste proceeded through the Southeast Landfill area. This is currently an open



Source: ESE, 1984

Figure 4.3-2
AREAS OF POTENTIAL CONTAMINATION
SOUTH AND EAST BOUNDARIES

INSTALLATION
RESTORATION PROGRAM
Vance Air Force Base



area between the roadway and the south boundary drainage ditch, the northern portion of which is used to store fill material and dried sludge from the sewage treatment plant. This landfill reportedly contains little if any industrial waste, as other methods for disposing of such material were used during part of the period it was operated. Base personnel report this area once sloped toward the south, but extensive placement of rubble fill has raised the surface to nearly level. The solid wastes are believed to be 10 to 20 feet below existing grade. Aerial photographs substantiate the presence of rubble fill in this area.

Chemical Disposal Pits

The Chemical Disposal Pit area is located between the south boundary drainage ditch and the existing roadway. This area was active from approximately 1960 to 1970 and was used for disposal of metal plating solutions, hospital waste, and possibly other industrial liquids. Pits approximately 10 to 12 feet deep were dug randomly in the area on an as-needed basis. Liquid wastes were then poured into the pit, and it was gradually refilled with the excavated material as the liquid soaked into the soil. It was reported that this took place approximately twice each year, with approximately 500 to 1,000 gal being dumped on each occasion. The area was subsequently used for rubble and fill dumping which leveled the original slope to the south, and it is estimated that the disposal pits are 5 to 10 feet below existing grade. This is currently an open, unused area.

Tank Sludge Disposal Area

Located between the drainage ditch and the south base boundary, the Tank Sludge Disposal area was used on a one-time basis in 1967. The sludge generated from a fuel storage tank cleaning program was transported to the site and buried in a large pit. The waste was covered with the excavated material. The quantity of waste buried in this currently unused area was not reported. Base fuels estimates cleaning of the JP4 tanks generates approximately 1000 gal of sludge.

Firefighter Training Area

The area where the existing Firefighter Training Area is located at the southern end of Elam road was reportedly used as a dumping area for a

variety of flammable liquids until approximately 1970. These liquids, which included fuel, oils, and solvents, were reportedly dumped in a shallow depression in the ground surface and periodically ignited during training exercises. No reliable estimates were available of quantities dumped, as this was an uncontrolled process. The existing fire training pit, a lined basin with provision for fuel storage and runoff control, is located on the site. This facility was upgraded in 1983 by addition of an oil/water separator on the drain line.

Bldg. 110 Area Storage Tank

From approximately 1970 to 1980, an unused fuel tank adjacent to Bldg. 110 was used for storage of a wide variety of materials including waste solvents, metal treatment solutions, and waste oils. Although no waste has been contributed to the tank since 1980, it still contains an estimated 3 feet of sludge which could not be removed when the tank was pumped out.

Hazardous Waste Accumulation Point

This area is a fenced dirt yard just north of Bldg. 122. It has been used since 1980 for the accumulation of drummed wastes pending off-base disposal through DPDO. Wastes present generally include waste solvents, metal treatment sludges, waste oils, and contaminated fuel.

4.4 HAZARD ASSESSMENT

Of the eight areas of potential contamination identified, six were determined to require rating with the HARM system, based on the decision tree present in Fig. 1.3-1. The Bldg. 110 Area Storage Tank and the Hazardous Waste Accumulation Point were eliminated at this point due to the lack of potential for contamination and migration. No evidence was found of leakage and spills at either site.

Each of the sites discussed in Sec. 4.3 was rated using the HARM. The HARM scores are summarized in Table 4.4-1. The process of rating potential hazards using the HARM system is described in detail in Appendix F. Basically the method uses numerical ratings for a number of

Table 4.4-1 - Summary of HARM Scores

Rank	Site	Receptors Subscore	Waste Characteristics Score	Pathways Subscore	Waste Management Factor	Total Score
1	Chemical Disposal Pits	61	100	52	1.0	71
2	Firefighter Training Area	61	64	44	1.0	56
3	Tank Farm Landfill	64	56	44	1.0	55
4	East Boundary Landfill	61	30	52	1.0	48
5	Tank Sludge Disposal Area	61	37	44	1.0	47
6	Southeast Landfill	61	10	52	1.0	41

Source: ESE, 1984.

discrete variables to calculate subscores for three categories. These categories represent the risk of human exposure (Receptors), the nature and quantity of waste (Waste Characteristics), and the potential migration routes (Pathways).

Evaluation of some variables within the Receptor subscore required some judgment in using available information. In particular, the distance to the nearest well and the population served by ground water in the vicinity could not be established with certainty using available information. Instead of leaving this critical factor out of the calculation, guidance provided in the National Oil and Hazardous Substances Contingency Plan (40 CFR 300) for use of the EPA Hazard Ranking System (HRS) was applied since this system was the basis for HARM. Specifically, occupied dwellings which are not within the service area of any public water supply and had no other reported water source were assumed to have a private well. Populations were estimated by map inspection and ground tours of neighborhoods, assuming an average of four persons per household (see Sec. 3.4.2).

Waste characteristics were evaluated based on information obtained in interviews with base personnel. In cases where the waste was a mixture of substances with differing characteristics, the most critical waste was used for each variable. For example, a mixture of metal treatment sludges and waste solvents might be rated high for flammability due to the solvents and high for persistence due to the metals in the sludge. This is based on the guidance provided for HRS.

For the Pathways subscore, environmental factors such as rainfall intensity and net precipitation were evaluated using standard references such as the Climatic Atlas of the United States (USDC, 1979). Erosion potential was based on direct observation, while depth to groundwater was based on available boring logs, geologic data, and interviews. A multiplication factor to account for Waste Management Practices is applied to the average of the three subscores to yield a final score. HARM provides only three choices, 1.0, 0.95, and 0.1, to indicate no containment, limited containment, and fully contained and in full compliance.

5.0 CONCLUSIONS

The goal of the IRP Phase I study is to identify sites where there is potential for environmental contamination resulting from past waste disposal practices and to assess the probability of contaminant migration from these sites. The conclusions are based on the assessment of the information collected from the Project Team's field inspection, review of records and files, review of the environmental setting, and interviews with base personnel, past employees, and state and local government employees.

Chemical Disposal Pits

This open area adjacent to the south boundary drainage ditch was used to dig a series of liquid waste disposal pits from approximately 1960 to 1970. Soils are relatively impermeable, but potential contamination or migration exists, primarily for metals since materials disposed of were mostly plating solutions and sludges. The HARM score for this site is 71.

Firefighter Training Area

Fuels, oils, and solvents were reportedly dumped in a shallow ground depression at this location until approximately 1970. Soils are relatively impermeable, and groundwater conditions are unclear. The existing Firefighter Training Area is located on the site. Potential exists for contamination and migration from solvents, fuels, and oils. The HARM rating for this site is 56.

Tank Farm Landfill

This site was operated as a general purpose trench and fill landfill prior to 1952. Operating personnel reported the contents are mostly household solid wastes, but included containerized liquids. Some lead gasoline tank sludge was buried under the existing berm around Tank 267. This site is immediately adjacent to the ditch exiting the base which flows to a small lake used for fishing and boating. Soils in this area have relatively low permeability and the movement and occurrence of ground water are not clearly defined. The potential exists for contamination and migration from metals, solvents, fuels, and oils. The HARM Score for this site is 55.

East Boundary Landfill

Operated as a general purpose trench type landfill from approximately 1952 to 1957, this area is currently cultivated as garden plots by base personnel. Materials deposited here were mostly general solid waste and some industrial liquids. Soils are of relatively low permeability and ground water occurrence/movement is not clearly defined. Potential exists for contamination by and/or migration of metals, solvents, fuels, and oils. This site received a HARM score of 48.

Tank Sludge Disposal Area

Used as a one-time disposal area for sludge from fuel tanks, this site is between the drainage ditch and south base boundary. Potential exists for metals contamination and migration. Soils are relatively impermeable and ground water conditions are unclear. The HARM score for this site is 47.

Southeast Landfill

Trench and fill disposal of solid waste proceeded through this area from 1958 to 1965. This is currently an open area adjacent to the south boundary drainage ditch. Disposal of industrial wastes in this area is thought to be limited. Some potential exists for contamination by metals and solvents. Soils are relatively impermeable, and ground water conditions are not clearly defined. This site received a HARM score of 41.

Additional sites identified but not rated are the Bldg. 110 Area Storage Tank and the Hazardous Waste Accumulation Point, which did not exhibit contamination/migration potential.

6.0 RECOMMENDATIONS

The information gathered through interviews and research were sufficient to locate and categorize the on-base disposal sites. A Phase II monitoring program is recommended to accomplish the following objectives:

1. Obtain information regarding aquifer characteristics below VAFB. Such information would include stratigraphy, direction of ground water flow, and permeability.
2. Determine the nature and extent of surface water, ground water, soil, and sediment contamination that might have resulted from past storage, handling, and disposal practices.

In addition, recommendations are made regarding facilities and procedures currently utilized in the handling, storage, and disposal of hazardous materials.

6.1 PHASE II MONITORING RECOMMENDATIONS

The following actions are recommended to further assess the potential for environmental contamination from waste disposal areas at VAFB. The recommended actions are intended to be used as a general guide in the development and implementation of the Phase II study. The recommendations include the approximate number of ground water monitoring wells, type(s) of samples to be collected (e.g., soil, water, sediment) and suspected contaminants for which analyses should be performed. The number of ground water monitoring wells recommended corresponds to the number of wells required to adequately determine whether contaminants are migrating from a given source. The final number of ground water monitoring wells required to determine the extent of and define the movement of contaminants from each site will be determined as part of the Phase II investigation.

Recommended ground water monitoring should be performed periodically in order to assess contaminant migration under different precipitation regimes. After 1 year of monitoring, the data should be evaluated to determine the need for further action (if any). All drilling activities should be conducted

by an Oklahoma-licensed water well driller. All monitor wells should be constructed of threaded-joint casing and factory-slotted screen. Under no circumstances should PVC primer or PVC glue be used for the construction of well casing or bailers. The wells should be installed to the depth of bedrock, and the screen should extend over the entire saturated interval and approximately 1 foot above the water table. The wells need to be screened above the water table to detect nonmiscible, floating contaminants, such as petroleum products. Borehole geophysical logging of all VAFB wells is recommended to facilitate stratigraphic analysis. During drilling, Shelby tube samples should be taken to provide soils data and vertical permeability measurements. The top of the filter pack should be bentonite-sealed, and the annulus should be grouted to the surface. The well should be protected with pipe fitted with locking caps. The well should be developed to the fullest extent possible and surveyed both vertically and horizontally by a registered surveyor to obtain accurate well location distances and water level elevations. Water levels should be measured after recovery from well development and at the time of sampling. Slug tests should be conducted to determine horizontal permeability and to provide data for evaluation of flow rates.

Prior to initiation of any Phase II field activities, a detailed work plan should be prepared. This work plan should provide specific procedures to be followed in well construction, well logging, well installation, well development, surveying, water level measurements, aquifer testing, sampling, laboratory analysis, quality control, and reporting. All samples should be analyzed at a minimum for total petroleum hydrocarbons, halogenated and nonhalogenated solvents, metals, PCBs, and pesticides, using EPA-approved procedures. The solvent analytes should include at a minimum TCE, benzene, MIBK, carbon tetrachloride, MEK, methylene chloride, and acetone. The metal analytes should include cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. The recommended parameters include those compounds known or suspected to have been placed in the disposal sites. In addition, certain additional parameters for which drinking water standards exist are included. It is recommended that chemical analysis for metals include both total and dissolved fractions to quantify which metals are mobile, as well as the total amount of metal sorbed onto

suspended materials and, hence, potentially available for leaching. Because the oil and grease analysis by EPA Method 413.2 does not differentiate between extractables of biological origin or the mineral oils and greases of POL origin, the EPA Infrared (IR) Spectrophotometric Method for total recoverable petroleum hydrocarbons (EPA Method 418.1) is recommended for assessing POL contamination. Halogenated and nonhalogenated solvents, PCBs, and pesticides may be analyzed by EPA Methods 624 and 625 or comparable methods. All water samples should be analyzed for pH, conductivity, and oxidation-reduction potential at the time of sampling.

For the Tank Farm Landfill, it is recommended that four monitoring wells be installed around the known fill area (see Fig. 6.1-1). In addition, it is recommended that water and sediment samples be taken from the drainage ditch on the east side of the site, upstream from the sewage treatment plant outfall.

The five disposal sites identified along the south and east base boundaries are close together and similar in content. Thus, it is recommended that ground water monitoring in this area examine the aggregate effect of those sites. Initially, three wells should be installed north of the disposal sites and four wells between the sites and the boundary. Wells can be spaced evenly and located as necessary to accommodate obstacles. The south boundary drainage ditch should be sampled at the east boundary and at its upstream end. Water and sediment should be sampled at each location, preferably after the ditch has been flowing for at least 24 hours.

It is recommended that a composite soil sample be obtained from the upper 3 feet of soil in the Firefighter Training and East Boundary sites. These samples will be used to evaluate the potential hazard posed by near surface soil contamination in view of present and future uses of these sites. In addition, vegetation grown in the East Boundary landfill should be sampled and analyzed for metals.

Table 6.1-1 summarizes the recommended monitoring for VAFB Phase II investigations.

suspended materials and, hence, potentially available for leaching. Because the oil and grease analysis by EPA Method 413.2 does not differentiate between extractables of biological origin or the mineral oils and greases of POL origin, the EPA Infrared (IR) Spectrophotometric Method for total recoverable petroleum hydrocarbons (EPA Method 418.1) is recommended for assessing POL contamination. Halogenated and nonhalogenated solvents, PCBs, and pesticides may be analyzed by EPA Methods 624 and 625 or comparable methods. All water samples should be analyzed for pH, conductivity, and oxidation-reduction potential at the time of sampling.

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It is recommended that a composite soil sample be obtained from the upper 3 feet of soil in the Firefighter Training and East Boundary sites. These samples will be used to evaluate the potential hazard posed by near surface soil contamination in view of present and future uses of these sites.

Table 6.1-1 summarizes the recommended monitoring for VAFB Phase II investigations.

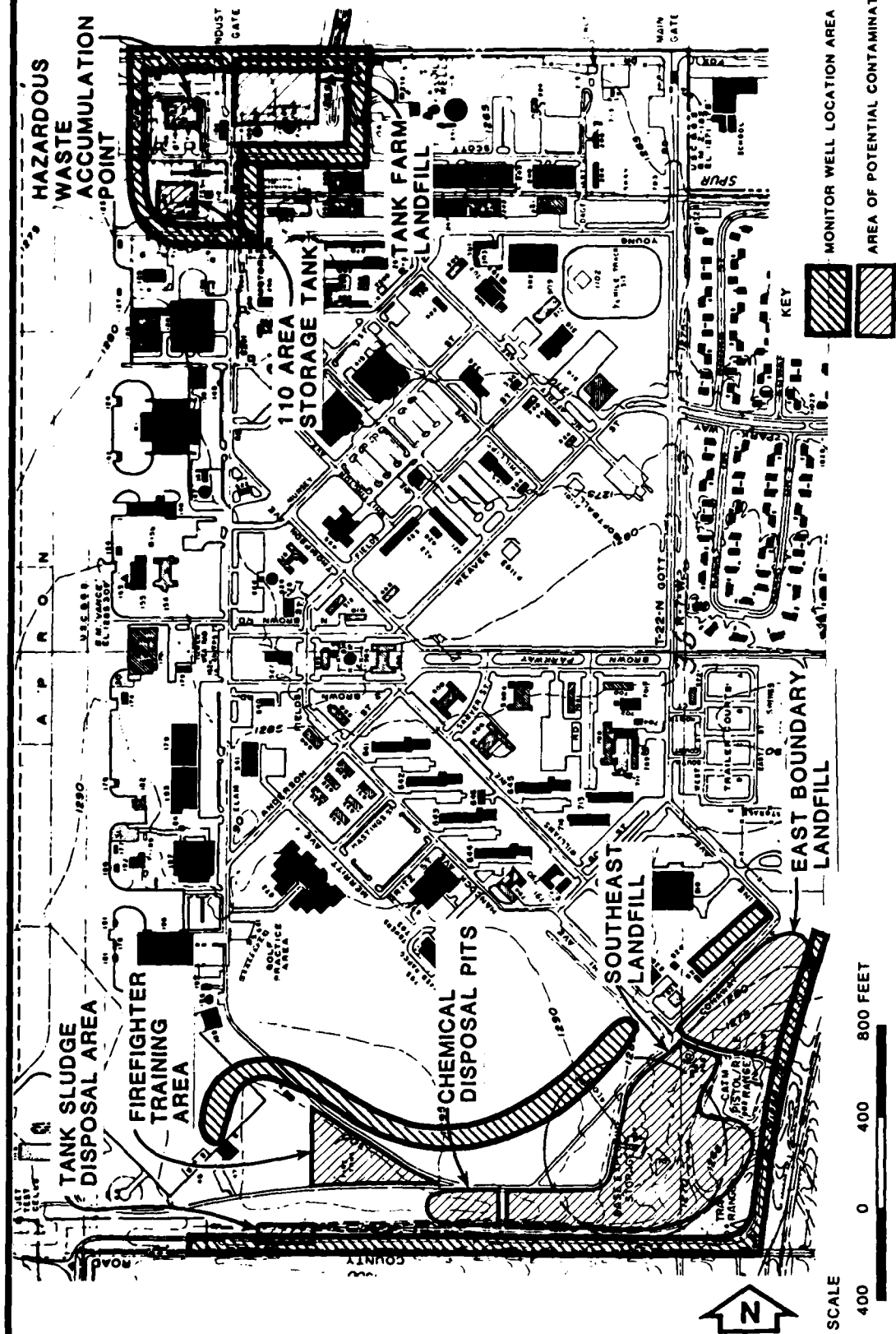


Figure 6.1-1
MONITOR WELL LOCATION AREAS

INSTALLATION RESTORATION PROGRAM Vance Air Force Base

Table 6.1-1. Summary of Recommended Monitoring for VAFB Phase II Investigations.

Site	HARM Score	Recommended Sampling	Recommended Analysis
South and East Disposal Chemical Disposal Pits	71	Install three wells north of disposal sites and four wells between the sites and the base boundary. Sample south boundary drainage ditch (water and sediment) at east boundary and at upstream end. Sample soil at Firefighter Training Area and East Boundary Landfill. Sample vegetation in East Boundary Landfill (metals only).	Total Petroleum hydrocarbons, halogenated and nonhalogenated solvents, metals, PCBs, pesticides.
Firefighter Training Area	56		
East Boundary Landfill	48		
Tank Sludge Disposal Area	47		
Southeast Landfill	41		
Tank Farm Landfill	55	Install four wells around site. Sample drainage ditch (water and sediment) upstream of STP outfall.	

Source, ESE, 1984.

6.2 EXISTING FACILITIES/PROCEDURES

The site visit and conversations with VAFB engineering personnel identified several areas requiring continued attention to insure regulatory compliance and guard against possible future contamination. The underground storage tank at Bldg. 110 which was used to store a variety of wastes in the past still contains an unknown amount of sludge. This sludge has not been completely characterized. The condition and integrity of the tank are not known. A detailed work plan should be prepared for emptying and evaluating this tank. If evidence of leakage is found, sampling and analysis should be undertaken to define the extent of contamination.

The ongoing effort for analysis, labeling, and off-base disposal of the transformers currently being held should be continued to completion.

Base personnel should examine alternatives for eliminating the release of fuels, wastewater, and fire suppressants which results from training exercises at KAux. This could be done by upgrading the KAux facilities to the level of those at VAFB or by transporting the KAux firefighting unit to VAFB for training exercises.

6.3 LAND USE GUIDELINES

Careful consideration should be given to the uses made of the disposal areas for the following reasons:

1. To provide the continued protection of human health, welfare, and the environment;
2. To insure that the migration of potential contaminants is not promoted through improper land uses;
3. To facilitate the compatible development of future USAF facilities; and
4. To allow for identification of property which may be proposed for excess or outlease.

In general, activities which would tend to disrupt the waste cells should be avoided so as not to facilitate contaminant migration. Such activities

include foundation and drainage ditch construction. To avoid trapping any volatile compounds that may be released from the disposal areas, structures should not be placed over the sites.

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APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
(Page 1 of 6)

AFESC	Air Force Engineering and Service Center
AGE	Aerospace Ground Equipment
Aquifer	A geologic formation, group of formations, or part of a formation capable of yielding water to a well or spring
Aquiclude	Geologic unit which impedes ground water flow
ATC	Air Training Command
BES	Bioenvironmental Engineering Services
Carbon tetrachloride	A solvent commonly in use until the 1960s; a suspected human carcinogen
Cadmium	A metal used in batteries and other industrial applications; highly toxic to humans and aquatic life
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CD	Contract/DPDO Disposal
CDP	Chemical Disposal Pits
CFR	Code of Federal Regulations
Contaminated fuel	Fuel which does not meet specifications for recovery or recycle
Contamination	Degradation of natural water quality to the extent that its usefulness is impaired; degree of permissible contamination depends on intended use of water
Chromium	A metal used in plating, cleaning, and other industrial applications; highly toxic to aquatic life at low concentrations, toxic to humans at higher levels
DEQPPM	Defense Environmental Quality Program Policy Memorandum

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
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DIS	Defense Investigative Service
Disposal of hazardous waste	Discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment, be emitted into the air, or be discharged into any waters, including ground water
DOD	Department of Defense
Downgradient	In the direction of decreasing hydraulic static head; the direction in which ground water flows
DPDO	Defense Property Disposal Office
Effluent	Liquid waste discharged in its natural state or partially or completely treated from a manufacturing or treatment process
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
°F	Degrees Farenheit
ft	feet
gal	gallon
gal/yr	gallons per year
gpd	gallons per day
gpm	gallons per minute
Ground water	Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure
HARM	Hazard Assessment Rating Methodology

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
(Page 3 of 6)

Hazardous waste	As defined in RCRA, a solid waste or combination of solid wastes which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed
HRS	Hazard Ranking System
IFR	Instrument Flight Rules
Infiltration	Movement of water through the soil surface into the ground
Iron	A metal commonly found in water as a consequence of dissolution of geologic materials; relatively nontoxic
IRP	Installation Restoration Program
ISCP	Installation Spill Control Plan
JP4	jet fuel used in T-37 and T-38 aircraft
KAux	Kegelman Auxiliary Field
kts	knots, nautical miles per hour
Lead	A metal additive to gasoline and used in other industrial applications; toxic to humans and aquatic life; bioaccumulates
lb/day	pounds per day
lb/yr	pounds per year
Leachate	A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
(Page 4 of 6)

Liner	A continuous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill, or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents, or leachate
MEK	methyl ethyl ketone, a solvent used in paint thinner, stripper, and a wide variety of industrial applications; suspected to be toxic to humans at high levels; potentially toxic to aquatic life
mg/l	milligrams per liter
MIBK	methyl isobutyl ketone, a solvent used in paint stripper, thinner, and a wide variety of industrial applications; suspected to be toxic to humans at high levels; potentially toxic to aquatic life
MOGAS	motor vehicle gasoline
mph	miles per hour
NA	not applicable
NCO	Noncommissioned Officer
ND	no data
n.d.	not dated
NDI	Nondestructive Inspection
Nickel	A metal used in batteries, plating, and other industrial applications; highly toxic to humans and aquatic life
NIPDWR	National Interim Primary Drinking Water Regulations
NPDES	National Pollutant Discharge Elimination System
OIC	Officer-in-Charge
PCB	Polychlorinated biphenyl—liquid used as a dielectric in electrical equipment; suspected human carcinogen; bioaccumulates in the food chain and causes toxicity to higher trophic levels

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
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PD-680	Petroleum-based cleaning solvent
Percolation	Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil
Permeability	The capacity of a porous rock, soil, or sediment transmitting a fluid without damage to the structure of the medium
pH	Negative logarithm of hydrogen ion concentration; an expression of acidity or alkalinity
PMEL	Precision Measurement Equipment Lab
POL	petroleum, oils, and lubricants
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
Recharge	Addition of water to the ground water system by natural or artificial processes
Silver	A metal used in photographic emulsions and other industrial operations; toxic to humans and aquatic life at low concentrations
SOAP	Spectrographic Oil Analysis Program
SPCC	Spill Prevention Control and Countermeasure (Plan)
Spill	An unplanned release or discharge of a hazardous waste onto or into air, land, or water
SS	Sanitary Sewer
STP	sewage treatment plant
TCE	trichloroethylene, a commonly used degreasing solvent; toxic to aquatic life and a suspected human carcinogen

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
(Page 6 of 6)

Upgradient	In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of ground water
USAF	U.S. Air Force
USAFETAC	U.S. Air Force Environmental Tech Applications Center
USGS	U.S. Geological Survey
USSCS	U.S. Soil Conservation Service
VAFB	Vance Air Force Base
Water table	Surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere
Zinc	A metal with a wide variety of industrial applications, particularly corrosion-resistant; highly toxic to aquatic life, slightly toxic to humans at high dose levels

APPENDIX B
TEAM MEMBER BIOGRAPHICAL DATA

ESE

PROFESSIONAL RESUME

BRUCE N. MCMASTER, Ph.D.
Senior Chemist/Division Director
Hazardous Waste Assessments

SPECIALIZATION

Toxic and Hazardous Waste Disposal, Hazardous Waste Site Investigations, Pollutant Fate Studies, Environmental Chemistry, Water Quality

RECENT EXPERIENCE

Records Search for U.S. Army Toxic and Hazardous Materials Agency, Project Director - Assessing environmental quality of 85 Army installations with regard to the use, storage, treatment and disposal of toxic and hazardous materials; define contaminants present, potential for off-site migration, and potential impacts on receptors; recommend sampling and analysis surveys for quantitative delineation of contamination problems; evaluate compliance status with all applicable environmental regulations.

Environmental Contamination Surveys for the U.S. Army Toxic and Hazardous Materials Agency, Project Director - Investigating 7 U.S. Army installations to confirm the presence of toxic and hazardous contaminants, and to define the extent of contamination and contaminant migration. Surveys include sampling and analysis of surface waters, ground water, soil, sediments, sewers, and buildings. Conduct alternative analyses for potential mitigative measures.

Initial Assessment Studies for the Naval Energy and Environmental Support Activity, Project Director - Evaluating 4 Naval installations with regard to past hazardous waste generation, storage, treatment, and disposal practices. Investigations include records review, aerial and ground site surveys, employee interviews, and limited sampling and analysis including geophysical techniques. Determine extent of contamination at former disposal/spill sites, potential for contaminant migration, and potential effects on human health and the environment.

EDUCATION

Post-Doctoral	1977-1978	Environmental Engineering/ Science	University of Florida
Ph.D.	1976	Chemistry	University of Florida
B.S.	1968	Chemistry	University of Delaware

REGISTRATIONS/ASSOCIATIONS

American Chemical Society, Member
American Defense Preparedness Association, Member

RECENT PUBLICATIONS

Approximately 80 hazardous waste site investigations of U.S. military installations.

ESE

PROFESSIONAL RESUME

JACKSON B. SOSEBEE, JR., M.S.
Senior Scientist

SPECIALIZATION

Hazardous Waste Studies, Environmental Chemistry, Mathematical Modeling, Pollutant Fate Studies

RECENT EXPERIENCE

USAF Installation Assessment, Team Leader - Assessment of present and historical waste disposal activities at Vance Air Force Base, Oklahoma.

Rocky Mountain Arsenal Monitoring Plan, Task Manager - Preparing comprehensive monitoring plan to assess extent of off-post contamination at RMA, Colorado. Program includes ground water, surface water, sediment, potable water, air quality, and biota.

Cordova Chemical Site, Project Manager - Remedial investigation/feasibility study of hazardous waste disposal site in Michigan.

USATHAMA Navajo and Wingate Depot Activities, Project Manager - Environmental studies of U.S. Army installations in New Mexico and Arizona to determine if toxic or hazardous materials are migrating beyond installation boundaries by surface or subsurface routes or if the potential for such migration exists. Project included installation of monitor wells, collection of environmental samples, laboratory analysis for chemical contaminants, and presentation of findings.

USATHAMA, Ft. Gillem, Project Manager - Assessment of ground water and surface water contamination resulting from landfills containing hazardous materials.

Environmental Protection Agency (EPA) Pollutant Fate, Project Director - Assessments of the environmental fate and effects of chemicals listed by the Interagency Testing Committee as potential hazards.

USATHAMA, Installation Assessments, Project Scientist - Conducted assessments of surface water, ground water, and air quality at military installations throughout the U.S., including Ft. Carson, Colorado. Evaluated the impact of landfill leachate on ground water quality.

EDUCATION

M.S.	1974	Environmental Studies	University of Montana
B.S.	1969	Chemistry	Texas Tech University

AFFILIATIONS

American Chemical Society (ACS)
American Society for Testing and Materials (ASTM)
Society for Environmental Toxicology and Chemistry
Colorado Ground Water Association

PUBLICATIONS

Ten technical publications and presentations in areas of hazardous waste, environmental chemistry, quality control, computer applications, mathematical modeling.

ESE

PROFESSIONAL RESUME

WILLIAM G. FRASER, B.S., P.E.
Senior Associate Engineer

SPECIALIZATION

Water Quality/Resources Engineering, Environmental Impact Assessment,
Groundwater Hydrology, Siting and Environmental Studies

RECENT EXPERIENCE

USAF Installation Assessment - Currently evaluating present and
historical waste disposal practices at Vance Air Force Base, Oklahoma.

Navy Installation Assessments - Worked as the Environmental Engineer on
a project team examining historical waste handling practices and disposal
sites at several Naval Bases. Studied waste types and quantities, and
assessed disposal site suitability based on hydrogeologic characteristics,
neighboring land use, and contaminant migration potential.

Siting Studies - Worked as staff member performing hydrologic, water
quality and air quality studies related to siting and licensing of major
mining and power facilities.

Field Investigations - Streamflow measurement, water sampling, dam site
investigations, and groundwater testing at numerous sites in Colorado and
the West.

USATHAMA Installation Assessments - Worked as the Environmental
Engineer on a project team examining waste disposal practices at several
Army Bases, including Ft. Carson, Colorado. Examined various industrial
operations and an industrial waste treatment plant handling oily
wastewater.

USATHAMA Environmental Survey - Evaluated the nature and extent of
contaminant migration from abandoned landfill sites containing solvents,
POL, pesticides, and medical supplies. Reviewed surface and
groundwater analytical data and calculated pollutant mass influx at
installation boundary based on surface runoff and groundwater flow.

EDUCATION

B.S.	1975	Civil/Environmental Engineering	University of Connecticut
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REGISTRATION

Registered Professional Engineer, State of Colorado, 1983

ASSOCIATIONS

American Society of Civil Engineers
American Water Resources Association

ESE

PROFESSIONAL RESUME

KEITH C. GOVRO, M.S.
Group Leader, Ecology

SPECIALIZATION

Ecosystem Impacts from Hazardous Waste Disposal Practices, Wildlife
Biology, Fisheries Biology, Water Quality

RECENT EXPERIENCE

Assessment of Hazardous Waste Management/Disposal Practices at
U.S. Army Installations, Team Scientist - Performed on-site inspections
with regard to the presence of toxic and hazardous materials, the
potential for off-site migration of contaminants, and both on-site and off-
site waste disposal practices. Evaluations based on review of existing
data bases, records and site surveys. Findings used to determine the
necessity for confirmatory sampling/analysis and decontamination
activities.

Delineation of Habitat Types through Aerial Photo Interpretation, St. Paul
District, Corps of Engineers, Project Manager - Delineated habitat types
within a 20,000-acre section of the Kickapoo River watershed in
southwestern Wisconsin through aerial photo interpretation. Computed
acreage for each habitat type by 20-foot contour interval. Resulting
data used to determine potential habitat losses associated with the
construction of the proposed LaFarge Reservoir.

IQ-ID Contract for Ecological Services, St. Paul District, Corps of
Engineers, Project Manager - Contract involves providing aquatic and
terrestrial ecological services to the St. Paul District on a work order
basis. Past work orders have involved ecological analysis of candidate
sites for dredged material placement with Pools 8 and 9 of the Upper
Mississippi River.

Biological Inventory of Federal Coal Reserve Area in Southeastern
Oklahoma, Bureau of Land Management, Subproject Manager - Conducted
field surveys of the vegetation, wildlife and fisheries resources within
the 372,000-acre area to provide a data base for assessment of future
impacts from mining operations.

Aquatic Ecosystem Surveys, Midwestern Rivers and Reservoirs - Served
as Project Manager and/or Project Biologist for numerous aquatic ecology
surveys within major Midwestern drainages such as the Mississippi,
Illinois, Kaskaskia, Des Moines, Missouri, Wabash and Iowa Rivers and
reservoirs such as Lake Hamilton, Lake St. Louis, Lake Springfield, and
Newton Lake.

Bioassay of Dredge Spoil Impacts on Aquatic Organisms, U.S. Army Corps
of Engineers, Project Scientist - Participated in static and flow-through
bioassays assessing impacts to aquatic organisms from exposure to dredge
spoils.

EDUCATION

M.S.	1977	Fisheries Biology	Iowa State University
B.S.	1975	Wildlife and Fisheries Biology	Iowa State University

APPENDIX C

LIST OF INTERVIEWEES AND OUTSIDE CONTACTS

APPENDIX C
LIST OF INTERVIEWEES
(Page 1 of 2)

<u>Position</u>	<u>Dates of Service</u>
Gen. Foreman-Aircraft Maintenance	23
Gen. Foreman-Aircraft Maintenance	24
Aircraft Maintenance-Hazardous	7
Waste Monitor	
Aircraft Maintenance	36
Heavy Equipment Operator	24
Lead man - T-37 Maintenance	9
Lead man - NDI	12
Chief Entomologist	16
Asst. Fire Chief	24
Station Chief	23
Asst. Supervisor, Support and Maintenance	14
Aero Repair	9
Base Fuels	8
USAF Construction Inspector	37
Community Planner	4
Fireman	
Plating Shop Worker	1
Photographer	
Graphics Supervisor	
NCOIC, BES	5
Environmental Coordinator	10

APPENDIX C
LIST OF OUTSIDE CONTACTS
(Page 2 of 2)

Frank Hromas, Assistant Utility Supervisor
City of Waukomis
Waukomis, Oklahoma
405-758-1146

Raymond Brittain, Utility Director
City of Enid
Enid, Oklahoma
405-234-0400

Oklahoma Geological Survey
Norman, Oklahoma
405-325-3031

University of Oklahoma Library
Norman, Oklahoma
405-325-4142

Phillips University Library
Enid, Oklahoma
405-237-4444

Dannie Spiser, Ground Water Geologist
Oklahoma Water Resources Board
Oklahoma City, Oklahoma
405-271-2572

U.S. Geological Survey Library
Denver, Colorado
303-234-4133

Gary Collins, Environmental Health Supervisor
Garfield County Health Department
Enid, Oklahoma
405-233-0650

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INSTALLATION RESTORATION PROGRAM PHASE I RECORDS SEARCH
VANCE AIR FORCE BASE OKLAHOMA(U) ENVIRONMENTAL SCIENCE
AND ENGINEERING INC DENVER CO JUL 84 F08637-83-G-0010

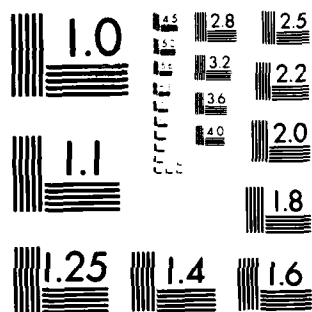
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APPENDIX D
MASTER LIST OF SHOPS AND LABS

APPENDIX D
MASTER LIST OF SHOPS
(Page 1 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste	Comments
Base Fuels	116	Yes	Yes	Supplies JP4, MOGAS, oils for base - waste limited to tank cleaning sludge disposed of by contract.
Security Police	204	Yes	No	Keeps small stock of mace, tear gas, and HC smoke - waste limited to spent containers.
T-38 Maintenance	141	Yes	Yes	Provides scheduled maintenance for T-38s - see Table 4.2-1.
Metal Plating	128	Yes	Yes	see Table 4.2-1.
Instrument Shop	128	Yes	No	Small quantities of solvent used in repair/ maintenance of aircraft instruments - waste limited to empty containers.
Electric Shop	128	Yes	Yes	see Table 4.2-1.
Sheet Metal	128	Yes	Yes	Some consumptive use of MEK; other wastes - see Table 4.2-1.
SOAP Lab	130	Yes	Yes	Spectrographic Oil Analysis Program uses some solvents in testing oil samples before recycling.

APPENDIX D
MASTER LIST OF SHOPS
(Page 2 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste	Comments
Precision Measurement Laboratory (PMEL)	128	Yes	Yes	see Table 4.2-1.
Battery Shop	128	Yes	Yes	see Table 4.2-1.
Support Equipment (AGE)	126	Yes	Yes	Maintains aircraft support equipment, primarily starting units, soon to be replaced by centralized system.
Non Destructive	130	Yes	Yes	Operation introduced to base in 1967 generates several wastes as shown in Table 4.2-1.
Paint Shop	128	Yes	Yes	Produces mostly empty containers in waterfall spray operation for small parts (see Table 4.2-1).
Aero Repair	129	Yes	Yes	Provides heavy/nonscheduled maintenance - limited use of Naptha and MEK in cleaning - waste limited to empty containers.
Machine Shop	128	Yes	Yes	Oil and solvents used in cleaning and cooling cutting tools - see Table 4.2-1.
Jet Engine Test Cell	47	Yes	Yes	see Table 4.2-1.

APPENDIX D
MASTER LIST OF SHOPS
(Page 3 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste	Comments
Fuel Cell Maintenance	188	Yes	Yes	see Table 4.2-1.
Fire Department	140	Yes	No	Provides maintenance/recharge of extinguishers in addition to fire response/training - uses AFFF.
Central Life Support	174	Yes	No	Some use of adhesives/solvents - waste limited to empty containers.
T-37 Squadron	179	No	No	Aircraft operations area.
Parachute Shop	111	Yes	No	Repairs/packs parachutes - uses some solvents.
Tire Shop	170	Yes	Yes	see Table 4.2-1.
Wash Rack	170	Yes	No	Hangar area - used for aircraft washing.
Weather Maintenance	170	No	No	Maintenance for weather squadron.
Disaster Preparedness	156	Yes	No	Holds stocks of M258 and M13 Decontamination kits for emergency use.
Paint Hangar	192	Yes	Yes	Stripping shed (182) used when weather permits- see Table 4.2-1.

APPENDIX D
MASTER LIST OF SHOPS
(Page 4 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste	Comments
T-37 Maintenance	195	Yes	Yes	Location used for T-33 before T-37 was on base (see Table 4.2-1).
T-38 Squadron	183	Yes	No	Keep some toluene on hand for cleaning with gauze pads.
Jet Engine Shop	187	Yes	Yes	see Table 4.2-1.
Carpenter Shop	274	Yes	No	Keeps small stock of acetone (see Table 4.2-1).
Paint Shop	274	Yes	Yes	see Table 4.2-1.
Grounds	284	Yes	No	Storage location for small containers of herbicides.
Herbicide Storage	194	Yes	No	Waste limited to empty cans/bags.
Plumbing Shop	270	No	No	
Pavements	270	No	No	
Electric	270	No	No	

APPENDIX D
MASTER LIST OF SHOPS
(Page 5 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste	Comments
Swimming Pools	701	Yes	No	Chlorine cylinders are recharged and reused.
Sewage Treatment Plant	251	Yes	No	Laboratory chemicals/reagents used in testing.
Entomology	255	Yes	No	Waste limited to empty containers.
Motor Pool	298	Yes	Yes	see Table 4.2-1.
Auto Hobby Shop	301	Yes	Yes	see Table 4.2-1.
Arts and Crafts	303	No	No	
Bowling Alley	345	No	No	
Photo Hobby Shop	606	Yes	No	Quantities limited due to 1 to 2 users/week.
Photo Lab	604	Yes	No	Solutions go to sanitary sewer after silver recovery.
Reproductions	604	Yes	No	Uses some methylene chloride - waste limited to empty container.
Data Processing	528	No	No	

APPENDIX D
MASTER LIST OF SHOPS
(Page 6 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste	Comments
UPT/IFS	672	Yes	Yes	see Table 4.2-1.
Graphics	690	No	No	
Film Library	690	No	No	
Clinics	810	Yes	No	X-ray solutions to sanitary sewer; infectious waste autoclaved and disposed of as solid waste.
Officers/NCO Clubs	430 708	No	No	
Bx Service Station	522	Yes	Yes	see Table 4.2-1.
2110 Communications Squadron	794	Yes	Yes	see Table 4.2-1.
Base Exchange	410	Yes	No	Stores paints, solvents.

APPENDIX E
PHOTOGRAPHS OF DISPOSAL/SPILL SITES



FIREFIGHTER TRAINING AREA AND SLUDGE DISPOSAL AREA



SOUTHEAST LANDFILL

March 1984

**AREAS OF POTENTIAL
CONTAMINATION**

**INSTALLATION
RESTORATION PROGRAM
Vance Air Force Base**



CHEMICAL DISPOSAL PITS

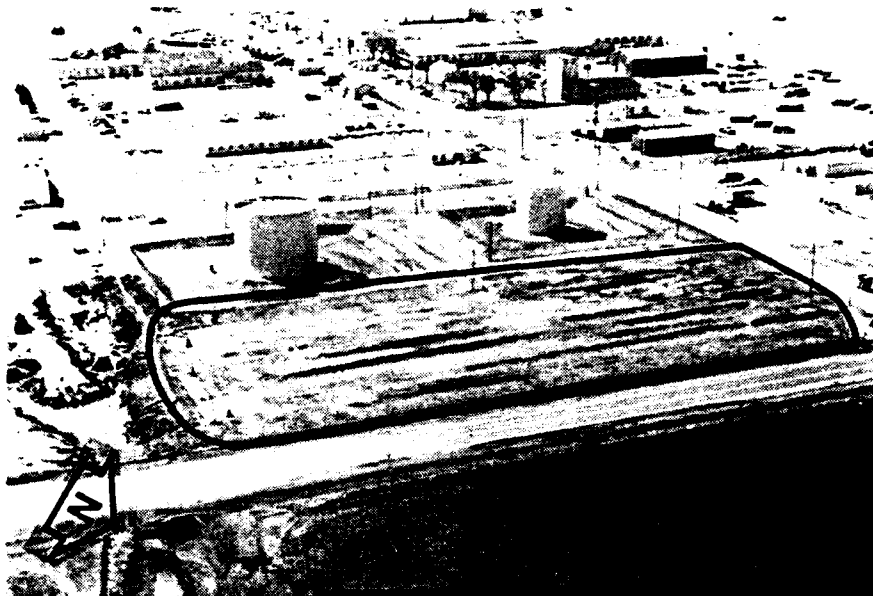


AREA 110 TANK AND HAZARDOUS WASTE STORAGE AREA

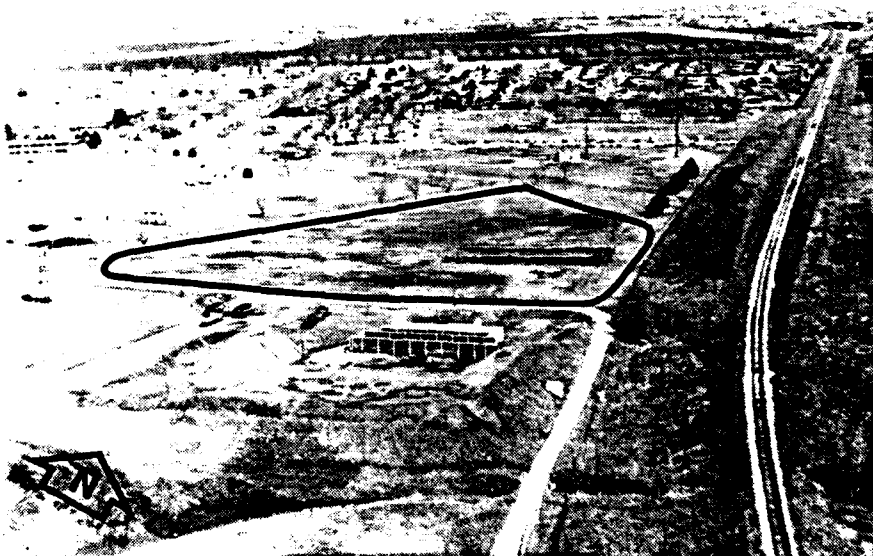
March 1984

**AREAS OF POTENTIAL
CONTAMINATION**

**INSTALLATION
RESTORATION PROGRAM
Vance Air Force Base**



TANK FARM LANDFILL



EAST BOUNDARY LANDFILL

March 1984

AREAS OF POTENTIAL
CONTAMINATION

INSTALLATION
RESTORATION PROGRAM
Vance Air Force Base

APPENDIX F

USAF IRP HAZARD ASSESSMENT RATING METHODOLOGY

USAF INSTALLATION RESTORATION PROGRAM
HAZARD ASSESSMENT RATING METHODOLOGY

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

"develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from USAF Occupational Environmental Health Laboratory (OEHL), Air Force Engineering Services Center (AFESC), Engineering-Science (ES) and CH₂M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering Science, and CH₂M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data readily obtained during the Record Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, potential pathways for waste contaminant migration, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories.

HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART

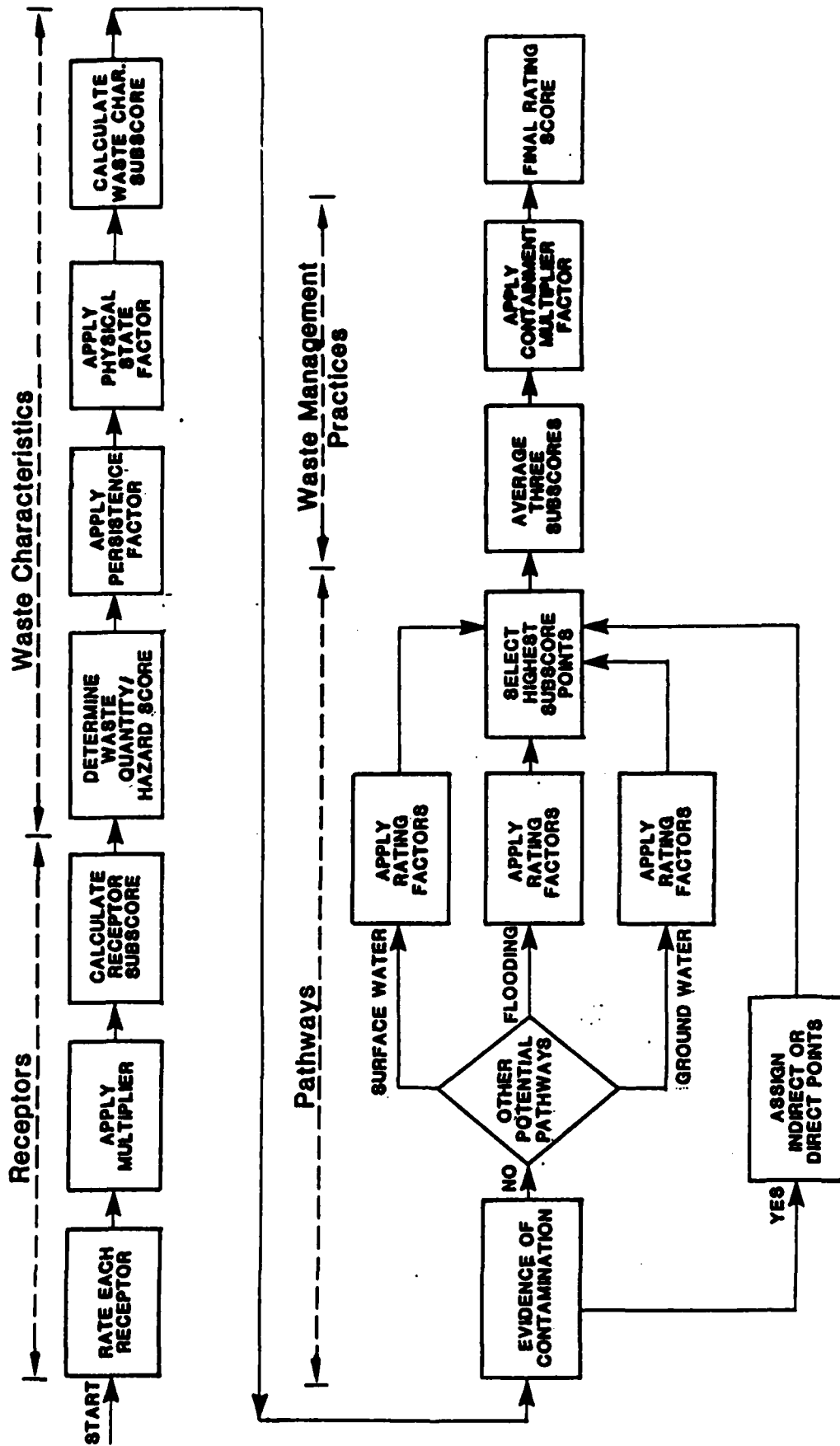


FIGURE 1

FIGURE 2
HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE _____
 LOCATION _____
 DATE OF OPERATION OR OCCURRENCE _____
 OWNER/OPERATOR _____
 COMMENTS/DESCRIPTION _____
 SITE RATED BY _____

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		6		

Subtotals _____

Receptors subcore (100 X factor score subtotal/maximum score subtotal) _____

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) _____
2. Confidence level (C = confirmed, S = suspected) _____
3. Hazard rating (H = high, M = medium, L = low) _____

Factor Subcore A (from 20 to 100 based on factor score matrix) _____

B. Apply persistence factor
 Factor Subcore A X Persistence Factor = Subcore B

_____ X _____ = _____

C. Apply physical state multiplier

Subcore B X Physical State Multiplier = Waste Characteristics Subcore

_____ X _____ = _____

FIGURE 2 (Continued)

Page 2 of 2

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor sub score of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore _____

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		

Subtotals _____

Subscore (100 X factor score subtotal/maximum score subtotal) _____

2. Flooding

Subscore (100 x factor score/3) _____

3. Ground-water migration

Depth to ground water		8		
Net precipitation		6		
Soil permeability		8		
Subsurface flows		8		
Direct access to ground water		8		

Subtotals _____

Subscore (100 x factor score subtotal/maximum score subtotal) _____

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore _____

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	_____
Waste Characteristics	_____
Pathways	_____
Total _____ divided by 3 =	_____
	Gross Total Score

- B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

_____ X _____ =

TABLE 1
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

I. RECEPTORS CATEGORY	Rating Factors	Rating Scale Levels			Multiplier	
		0	1	2		
A.	Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100	4
B.	Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C.	Land Use/zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential	3
D.	Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E.	Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination.	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands.	10
F.	Water quality/use designation of nearest surface water body	Agricultural or Industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies	6
G.	Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, municipal water available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	9
H.	Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000	6
I.	Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1,000	6

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

- S = Small quantity (<5 tons or 20 drums of liquid)
- M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
- L = Large quantity (>20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

- C = Confirmed confidence level (minimum criteria below)
 - o Verbal reports from interviewer (at least 2) or written information from the records.
 - o Knowledge of types and quantities of wastes generated by shops and other areas on base.
 - o Based on the above, a determination of the types and quantities of waste disposed of at the site.
- S = Suspected confidence level
 - o No verbal reports or conflicting verbal reports and no written information from the records.
 - o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site.

A-3 Hazard Rating

Hazard Category	Rating Scale Levels		
	0	1	2
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels

Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
90	L	C	M
	M	C	M
70	L	S	H
60	S	C	M
	M	C	M
50	L	S	M
	L	C	L
	M	S	M
	S	C	M
40	S	S	M
	M	S	M
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	M
20	S	S	L

Notes:
For a site with more than one hazardous waste, the waste quantities may be added using the following rules:
Confidence Level
o Confirmed confidence levels (C) can be added
o Suspected confidence levels (S) can be added
o Confirmed confidence levels cannot be added with suspected confidence levels
Waste Hazard Rating
o Wastes with the same hazard rating can be added
o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCH + SCH = LCH if the total quantity is greater than 20 tons.
Example: Several wastes may be present at a site, each having an MCH designation (50 points). By adding the quantities of each waste, the designation may change to LCH (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Persistence Criteria	Multiply Point Rating From Part A by the Following
Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Physical State	Multiply Point Total From Parts A and B by the Following
Liquid	1.0
Sludge	0.75
Solid	0.50

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 POTENTIAL FOR SURFACE WATER CONTAMINATION

Rating Factor	Rating Scale Levels				Multiplier
	0	1	2	3	
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet	8
Net precipitation	Less than -10 in.	-10 to + 5 in.	+5 to +20 in.	Greater than +20 in.	6
Surface erosion	None	Slight	Moderate	Severe	8
Surface permeability	0 to .15 clay (>10 ⁻² cm/sec)	.15 to 30 clay (10 ⁻² to 10 ⁻³ cm/sec)	30 to 50% clay (10 ⁻³ to 10 ⁻⁴ cm/sec)	Greater than 50% clay (<10 ⁻⁴ cm/sec)	6
Rainfall intensity based on 1 year 24-hr rainfall	<1.0 inch	1.0-2.0 inches	2.1-3.0 inches	>3.0 inches	8

B-2 POTENTIAL FOR FLOODING

Floodplain	Beyond 100-year floodplain	In 25-year floodplain	In 10-year floodplain	Floods annually	1
------------	----------------------------	-----------------------	-----------------------	-----------------	---

B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION

Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	6
Soil permeability	Greater than 50% clay (>10 ⁻² cm/sec)	30% to 50% clay (10 ⁻² to 10 ⁻³ cm/sec)	15% to 30% clay (10 ⁻³ to 10 ⁻⁴ cm/sec)	0% to 15% clay (<10 ⁻⁴ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	8
Direct access to ground water (through faults, fractures, faulty well casings, subsidence fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	8

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subcores.

B. WASTE MANAGEMENT PRACTICES FACTOR

The following multipliers are then applied to the total risk points (from A):

<u>Waste Management Practice</u>	<u>Multiplier</u>
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Fire Protection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III-B-3, then leave blank for calculation of factor score and maximum possible score.

APPENDIX G
HAZARD ASSESSMENT RATING METHODOLOGY FORMS

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Southeast Landfill
Location: Southeast Corner of Base between perimeter and access road
Date of Operation or Occurrence: 1955-1965
Owner/Operator: USAF Vance AFB
Comments/Description: Sanitary Landfill with some industrial waste
Site Rated By: W.G. Fraser

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	<u>1</u>	4	<u>4</u>	12
B. Distance to nearest well	<u>2</u>	10	<u>20</u>	30
C. Land use/zoning within 1-mile radius	<u>3</u>	3	<u>9</u>	9
D. Distance to reservation boundary	<u>3</u>	6	<u>18</u>	18
E. Critical environments within 1-mile radius of site	<u>2</u>	10	<u>20</u>	30
F. Water quality of nearest surface water body	<u>1</u>	6	<u>6</u>	18
G. Ground water use of uppermost aquifer	<u>3</u>	9	<u>27</u>	27
H. Population served by surface water supply within 3 miles downstream of site	<u>0</u>	6	<u>0</u>	18
I. Population served by ground water supply within 3 miles of site	<u>1</u>	6	<u>6</u>	18
SUBTOTALS			<u>110</u>	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>61</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) L
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) L

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor:

Factor Subscore A x Persistence Factor =
Subscore B 50 x 0.4 = 20

C. Apply physical state multiplier:

Subscore B x Physical State Multiplier =
Waste Characteristics Subscore 20 x 0.5 = 10

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore --

- B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
1. Surface water migration				
Distance to nearest surface water	<u>3</u>	8	<u>24</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Surface erosion	<u>2</u>	8	<u>16</u>	24
Surface permeability	<u>0</u>	6	<u>0</u>	18
Rainfall intensity	<u>2</u>	8	<u>16</u>	24
SUBTOTALS			<u>56</u>	108
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>52</u>
2. Flooding	<u>0</u>	1	<u>0</u>	3
Subscore (100 x factor score/3)				<u>0</u>
3. Ground water migration				
Depth to ground water	<u>2</u>	8	<u>16</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Soil permeability	<u>0</u>	8	<u>0</u>	24
Subsurface flows	<u>1</u>	8	<u>8</u>	24
Direct access to ground water	<u>0</u>	8	<u>0</u>	24
SUBTOTALS			<u>24</u>	114
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>21</u>

- C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 52

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 61
Waste Characteristics 10
Pathways 52
TOTAL 123 divided by 3 = 41 Gross total score

- B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

41 x 1.0 = 41

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Tank Farm Landfill
 Location: North of Tank 265 Adjacent to west gate
 Date of Operation or Occurrence: 1944-1950
 Owner/Operator: USAF Vance AFB
 Comments/Description: General purpose trench and fill landfill
 Site Rated By: W.G. Fraser

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	<u>1</u>	4	<u>4</u>	12
B. Distance to nearest well	<u>2</u>	10	<u>20</u>	30
C. Land use/zoning within 1-mile radius	<u>3</u>	3	<u>9</u>	9
D. Distance to reservation boundary	<u>3</u>	6	<u>18</u>	18
E. Critical environments within 1-mile radius of site	<u>2</u>	10	<u>20</u>	30
F. Water quality of nearest surface water body	<u>1</u>	6	<u>6</u>	18
G. Ground water use of uppermost aquifer	<u>3</u>	9	<u>27</u>	27
H. Population served by surface water supply within 3 miles downstream of site	<u>0</u>	6	<u>0</u>	18
I. Population served by ground water supply within 3 miles of site	<u>2</u>	6	<u>12</u>	18
SUBTOTALS			<u>116</u>	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>64</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor:

Factor Subscore A x Persistence Factor =
 Subscore B 100 x 0.5 = 50

C. Apply physical state multiplier

Subscore B x Physical State Multiplier =
 Waste Characteristics Subscore 50 x 1 = 50

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore

- B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	<u>3</u>	8	<u>24</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Surface erosion	<u>1</u>	8	<u>8</u>	24
Surface permeability	<u>0</u>	6	<u>0</u>	18
Rainfall intensity	<u>2</u>	8	<u>16</u>	24
SUBTOTALS			<u>48</u>	108
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>44</u>
2. Flooding	<u>0</u>	1	<u>0</u>	3
Subscore (100 x factor score/3)				<u>0</u>
3. Ground water migration				
Depth to ground water	<u>2</u>	8	<u>16</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Soil permeability	<u>0</u>	8	<u>0</u>	24
Subsurface flows	<u>1</u>	8	<u>8</u>	24
Direct access to ground water	<u>0</u>	8	<u>0</u>	24
SUBTOTALS			<u>24</u>	114
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>21</u>

- C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 44

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 64
Waste Characteristics 56
Pathways 44
TOTAL 164 divided by 3 = 55 Gross total score

- B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

55 x 1.0 = 55

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Tank Sludge Disposal Area
 Location: South boundary across from building 47
 Date of Operation or Occurrence: 1967
 Owner/Operator: USAF Vance AFB
 Comments/Description: One time burial of tank cleaning sludge
 Site Rated By: W.G. Fraser

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	<u>1</u>	4	<u>4</u>	12
B. Distance to nearest well	<u>2</u>	10	<u>20</u>	30
C. Land use/zoning within 1-mile radius	<u>3</u>	3	<u>9</u>	9
D. Distance to reservation boundary	<u>3</u>	6	<u>18</u>	18
E. Critical environments within 1-mile radius of site	<u>2</u>	10	<u>20</u>	30
F. Water quality of nearest surface water body	<u>1</u>	6	<u>6</u>	18
G. Ground water use of uppermost aquifer	<u>3</u>	9	<u>27</u>	27
H. Population served by surface water supply within 3 miles downstream of site	<u>0</u>	6	<u>0</u>	18
I. Population served by ground water supply within 3 miles of site	<u>1</u>	6	<u>6</u>	18
SUBTOTALS			<u>110</u>	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>61</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|----------|
| 1. Waste quantity (1=small, 2=medium, 3=large) | <u>L</u> |
| 2. Confidence level (1=confirmed, 2=suspected) | <u>S</u> |
| 3. Hazard rating (1=low, 2=medium, 3=high) | <u>M</u> |

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor:
 Factor Subscore A x Persistence Factor =
 Subscore B 50 x 1.0 = 50

C. Apply physical state multiplier:
 Subscore B x Physical State Multiplier =
 Waste Characteristics Subscore 50 x 0.7 = 37

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore

- B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	<u>3</u>	8	<u>24</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Surface erosion	<u>1</u>	8	<u>8</u>	24
Surface permeability	<u>0</u>	6	<u>0</u>	18
Rainfall intensity	<u>2</u>	8	<u>16</u>	24
SUBTOTALS			<u>48</u>	108
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>44</u>
2. Flooding	<u>0</u>	1	<u>0</u>	3
Subscore (100 x factor score/3)				<u>0</u>
3. Ground water migration				
Depth to ground water	<u>2</u>	8	<u>16</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Soil permeability	<u>0</u>	8	<u>0</u>	24
Subsurface flows	<u>1</u>	8	<u>8</u>	24
Direct access to ground water	<u>0</u>	8	<u>0</u>	24
SUBTOTALS			<u>24</u>	114
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>21</u>

- C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 44

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	<u>61</u>
Waste Characteristics	<u>37</u>
Pathways	<u>44</u>
TOTAL	<u>142</u> divided by 3 = <u>47</u> Gross total score

- B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

47 x 1.0 = 47

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Garden Plot Landfill
Location: Between Conway Street and the East Boundary
Date of Operation or Occurrence: 1950-1955
Owner/Operator: USAF Vance AFB
Comments/Description: General purpose trench and fill Landfill
Site Rated By: W.G. Fraser

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	<u>1</u>	4	<u>4</u>	12
B. Distance to nearest well	<u>2</u>	10	<u>20</u>	30
C. Land use/zoning within 1-mile radius	<u>3</u>	3	<u>9</u>	9
D. Distance to reservation boundary	<u>3</u>	6	<u>18</u>	18
E. Critical environments within 1-mile radius of site	<u>2</u>	10	<u>20</u>	30
F. Water quality of nearest surface water body	<u>1</u>	6	<u>6</u>	18
G. Ground water use of uppermost aquifer	<u>3</u>	9	<u>27</u>	27
H. Population served by surface water supply within 3 miles downstream of site	<u>0</u>	6	<u>0</u>	18
I. Population served by ground water supply within 3 miles of site	<u>1</u>	6	<u>6</u>	18
SUBTOTALS			<u>110</u>	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>61</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) L
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) L

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor:

Factor Subscore A x Persistence Factor =
Subscore B 50 x 0.8 = 40

C. Apply physical state multiplier:

Subscore B x Physical State Multiplier =
Waste Characteristics Subscore 40 x 0.7 = 30

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore --

- B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	<u>3</u>	8	<u>24</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Surface erosion	<u>2</u>	8	<u>16</u>	24
Surface permeability	<u>0</u>	6	<u>0</u>	18
Rainfall intensity	<u>2</u>	8	<u>16</u>	24
SUBTOTALS			<u>56</u>	108
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>52</u>
2. Flooding	<u>0</u>	1	<u>0</u>	3
Subscore (100 x factor score/3)				<u>0</u>
3. Ground water migration				
Depth to ground water	<u>2</u>	8	<u>16</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Soil permeability	<u>0</u>	8	<u>0</u>	24
Subsurface flows	<u>1</u>	8	<u>8</u>	24
Direct access to ground water	<u>0</u>	8	<u>0</u>	24
SUBTOTALS			<u>24</u>	114
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>21</u>

- C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 52

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 61
Waste Characteristics 30
Pathways 52
TOTAL 143 divided by 3 = 48 Gross total score

- B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

48 x 1.0 = 48

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Firefighter Training Area
 Location: Present location of building 995
 Date of Operation or Occurrence: 1948-1968
 Owner/Operator: USAF Vance AFB
 Comments/Description: Site for open burning of fuels in training
 Site Rated By: W.G. Fraser

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	<u>1</u>	4	<u>4</u>	12
B. Distance to nearest well	<u>2</u>	10	<u>20</u>	30
C. Land use/zoning within 1-mile radius	<u>3</u>	3	<u>9</u>	9
D. Distance to reservation boundary	<u>3</u>	6	<u>18</u>	18
E. Critical environments within 1-mile radius of site	<u>2</u>	10	<u>20</u>	30
F. Water quality of nearest surface water body	<u>1</u>	6	<u>6</u>	18
G. Ground water use of uppermost aquifer	<u>3</u>	9	<u>27</u>	27
H. Population served by surface water supply within 3 miles downstream of site	<u>0</u>	6	<u>0</u>	18
I. Population served by ground water supply within 3 miles of site	<u>1</u>	6	<u>6</u>	18
SUBTOTALS			<u>110</u>	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>61</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|----------|
| 1. Waste quantity (1=small, 2=medium, 3=large) | <u>L</u> |
| 2. Confidence level (1=confirmed, 2=suspected) | <u>C</u> |
| 3. Hazard rating (1=low, 2=medium, 3=high) | <u>M</u> |

Factor Subscore A (from 20 to 100 based on factor score matrix) 80

B. Apply persistence factor:
 Factor Subscore A x Persistence Factor = 80 x 0.8 = 64
 Subscore B

C. Apply physical state multiplier:
 Subscore B x Physical State Multiplier = 64 x 1.0 = 64
 Waste Characteristics Subscore

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore

- B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
1. Surface water migration				
Distance to nearest surface water	<u>3</u>	8	<u>24</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Surface erosion	<u>1</u>	8	<u>8</u>	24
Surface permeability	<u>0</u>	6	<u>0</u>	18
Rainfall intensity	<u>2</u>	8	<u>16</u>	24
SUBTOTALS			<u>48</u>	108
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>44</u>
2. Flooding	<u>0</u>	1	<u>0</u>	3
Subscore (100 x factor score/3)				<u>0</u>
3. Ground water migration				
Depth to ground water	<u>2</u>	8	<u>16</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Soil permeability	<u>0</u>	8	<u>0</u>	24
Subsurface flows	<u>0</u>	8	<u>0</u>	24
Direct access to ground water	<u>0</u>	8	<u>0</u>	24
SUBTOTALS			<u>16</u>	114
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>14</u>

- C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 44

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 61
Waste Characteristics 64
Pathways 44
TOTAL 169 divided by 3 = 56 Gross total score

- B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

56 x 1.0 = 56

3/15/84

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Chemical Disposal Pits
 Location: North side of South Boundary Drainage Ditch
 Date of Operation or Occurrence: 1960-1968
 Owner/Operator: USAF Vance AFB
 Comments/Description: Series of pits used to dump industrial waste
 Site Rated By: W.G. Fraser

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	<u>1</u>	4	<u>4</u>	12
B. Distance to nearest well	<u>2</u>	10	<u>20</u>	30
C. Land use/zoning within 1-mile radius	<u>3</u>	3	<u>9</u>	9
D. Distance to reservation boundary	<u>3</u>	6	<u>18</u>	18
E. Critical environments within 1-mile radius of site	<u>2</u>	10	<u>20</u>	30
F. Water quality of nearest surface water body	<u>1</u>	6	<u>6</u>	18
G. Ground water use of uppermost aquifer	<u>3</u>	9	<u>27</u>	27
H. Population served by surface water supply within 3 miles downstream of site	<u>0</u>	6	<u>0</u>	18
I. Population served by ground water supply within 3 miles of site	<u>1</u>	6	<u>6</u>	18
SUBTOTALS			<u>110</u>	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>61</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 1
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor:

Factor Subscore A x Persistence Factor =
 Subscore B 100 x 1.0 = 100

C. Apply physical state multiplier:

Subscore B x Physical State Multiplier =
 Waste Characteristics Subscore 100 x 1.0 = 100

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore --

- B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	<u>3</u>	8	<u>24</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Surface erosion	<u>2</u>	8	<u>16</u>	24
Surface permeability	<u>0</u>	6	<u>0</u>	18
Rainfall intensity	<u>2</u>	8	<u>16</u>	24
SUBTOTALS			<u>56</u>	108
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>52</u>
2. Flooding	<u>0</u>	1	<u>0</u>	3
Subscore (100 x factor score/3)				<u>0</u>
3. Ground water migration				
Depth to ground water	<u>2</u>	8	<u>16</u>	24
Net precipitation	<u>0</u>	6	<u>0</u>	18
Soil permeability	<u>0</u>	8	<u>0</u>	24
Subsurface flows	<u>1</u>	8	<u>8</u>	24
Direct access to ground water	<u>0</u>	8	<u>0</u>	24
SUBTOTALS			<u>24</u>	114
Subscore (100 x factor score subtotal / maximum score subtotal)				<u>21</u>

- C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 52

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 61
Waste Characteristics 100
Pathways 52
TOTAL 211 divided by 3 = 71 Gross total score

- B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

71 x 1.0 = 71

ATE
LME